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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

NOVEMBER 15.

Swansea Technical College Metallurgical Society:—General meeting. "Some Notes on the Measurement of Gas and Air in Metallurgical Furnaces," Paper by Messrs. L. S. Yoxall and T. D. Morgan.

NOVEMBER 18.

London Iron and Steel Exchange:—Meeting at the Liverpool Street Hotel. "Some Problems of our Steel Industry," address by F. W. Harbord.

Sheffield Metallurgical Association:—Ordinary meeting at Sheffield. "Technique of the Developments of Micro-Structures," Paper by T. H. Arnold.

NOVEMBER 20.

Institute of Metals (London Local Section):—Ordinary meeting. "Some Non-Ferrous Metals in Chemical Engineering," Paper by Richard Seligman.

Institute of British Foundrymen.

NOVEMBER 15.

Newcastle-upon-Tyne Branch (Junior Section):—Ordinary meeting. Lecture by D. Spowart.

East Midlands Branch:—Ordinary meeting at Nottingham. "Foundry Sands of Nottinghamshire and District," Paper by F. Hudson.

NOVEMBER 22.

Scottish Branch (Falkirk Section):—Ordinary meeting at Falkirk. "Some Problems I Have Met," Paper by H. Cowan, B.Sc.

Lancashire Branch (Junior Section):—Ordinary meeting at Manchester. "The Art of Brass Founding," Paper by F. W. Rowe, B.Sc.

A London Iron, Steel and Coal Exchange.

With the industrialisation of the South of England, a demand has arisen for a live Exchange which will take into consideration local requirements. The works at Slough, Watford, Bedford, Letchworth, Luton, Braintree, and the outlying suburbs of London constitute one great industrial activity in every way comparable with the Northern and Midland counterparts, and what is more, they are in general reasonably prosperous. For their industrial contacts they can resort to the Birmingham quarterly meeting, the London Iron and Steel Exchange and the London Coal Exchange. The objections to Birmingham are distance and infrequency; to the second, the bulk of the members are primarily interested in export and import; and the third, because of its limitations to fuel.

It appears to us to be desirable that the two London Exchanges should amalgamate, as their activities are largely complementary, and that a real effort should be made to interest the innumerable factories situated within 50 miles of the City.

In our unique position we are often impressed with the lack of knowledge which exists amongst these newer southern works of the existence of the local industrial activities, whilst being perfectly *au fait* with those of the North and Midlands. Actually, we find that the technical institutions are doing much more to effect introductions and disseminate the latest commercial information than are the official Exchanges. Now that the Engineers' Club has ceased to function, the demand for a meeting-place for industrialists has become more insistent, and the only bodies capable of supplying that need at the moment are the two London Exchanges.

If the committees of the two Exchanges could only get together and invite the representatives of these outlying works to meet them with a view of forming regular contacts by means of a joint exchange service, we are reasonably sure that the idea would be welcomed. If some of the buying were transferred to such an Exchange, the present congestion round the buyers' offices would be eased; the buyers' time saved and the sellers' travelling expenses reduced.

Once the London area works representatives got to know one another better, there would be presented a good chance of forming a West End club to replace the defunct Engineers' Club, the loss of which is still keenly felt in engineering circles.

Plain Speaking.

There are some very interesting movements taking place within the foundry industry at the moment. Two of its most important sections are holding meetings with the object of forming employers' federations. Should these meetings be successful, there will be created sufficient power, if they make proper contact with all the other foundry employers' federations, to inaugurate an over-all committee, which could serve the industry as a whole. Primarily, this *liaison* committee could represent the whole foundry industry for its international contacts. It could help in the unification of depreciation allowances for taxation purposes; it could speak authoritatively to the railway companies on questions of carriage of raw materials, and finally it could emulate the National Federation of Iron and Steel Manufacturers in its work of collecting statistics for the guidance of the industry. The main feature, to our mind, is that such a committee would place Great Britain in exactly the same position as America, Belgium, France, Germany, Holland and other countries. It would have a real political force, and would, for instance, be in a position to advise a Government on the possible effect of the imposition of tariffs on both its raw materials and its finished products.

Naturally, all this is somewhat dependent on the formation of these two associations, which are envisaged, and we can only hope that success will crown the efforts of those who have worked so hard to prepare the field. Whilst we are fully cognisant of the details of these developments, we do not feel that at the present juncture any comment is desirable, other than to ask participants to create the federations and then so to order their conduct that they place themselves in a position to do the best for the industries they represent and *serve*.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Semi-Steel.

To the Editor of The Foundry Trade Journal.

Sir,—I was very pleased to see Mr. H. J. Young's letter in The Foundry Trade Journal of October 30, and shall certainly take advantage of his offer.

I think, on Mr. Young's part, this is a genuine step towards progress, and I appreciate it as such. If every man who wrote a reply to any letter on any foundry subjects was animated by this spirit and was not so much concerned with the controversial side of matters it would be helpful, as almost all foundrymen can do with a little help and a little more knowledge, and most of us with a lot.

I think your contention that "Semi-steel" is a misleading name to be your idea, and if a metal, giving within certain limits of performance, was known as "Semi-steel," it would become a recognised name and must act up to limits of specification. We receive orders now with the percentage of steel given, but I have doubts of anyone being able to find it on analysis.

You have touched the right spot in saying that, given the same material in the cupola, two foundries will produce different results, but this is only because one foundry is not working correctly.

I object to each foundry having a special name for a special mixture, as this means nothing until proved, while if the suggestion carries, "Semi-steel" means a definite something.

Your previous reference to "Qualcast" is not relevant, as "Qualcast" simply says to purchasers that "we have a standard and call it 'Qualcast,'" but this has no reference to any special mixture, as while their mixtures vary according to requirements, the quality of "Qualcast" always remains.—Yours, etc.,

"Riley."

Catalogues Received.

Labour-Saving Devices.—A four-page leaflet from the United Dominions Trust, Limited, King's House, King Street, London, E.C.2, describes their system of enabling manufacturers to buy labour-saving devices on the hire-purchase system.

Aluminium Data.—The British Aluminium Company, Limited, of Adelaide House, King William Street, London, E.C.4, have sent us a number of loose sheets for incorporating in their publication "Aluminium Facts and Figures." Amongst those of major interest to our readers are (1) Sheet A115, which details all the specifications issued by the British Engineering Standards Association now current; (2) Sheets A121-2 now include the approximate melting points for all the alloys listed; and Sheet B27 (three leaves) gives new data on the heat-treatment of castings.

Power Generation. — Messrs. Crossley Brothers, Limited, of Openshaw, Manchester, have sent us four publications covering vertical compressorless Diesel engines and enclosed horizontal oil engines, together with descriptions of two typical installations. A perusal of the Diesel-engine brochure gave us a strong impression that the Crossley organisation gives full recognition of the part the foundry has played in the production of their admittedly high-grade machines. The stressing of the contribution made by the foundry to the finished engine in publicity matter, certainly shows to the enlightened buyer that there has been full co-operation from the designing stage onwards, which obviously reflects on the economic performance of the finished engine.

I.B.F. Branch-Presidents.

No. 1.—BURNLEY SECTION OF THE LANCASHIRE BRANCH.

Mr. A. Jackson served his apprenticeship in a small machine and general jobbing shop. He attended evening classes up to the age of 18, and from then until 21 was studying for the Civil Service.

He gained his experience of bench, floor and general work in jobbing and general engineering works. About twelve years ago he entered the service of Messrs. Howard & Bullough, Limited, textile engineers and founders of the Globe

Mr. A. Jackson.

Works, Accrington, and has been on the staff of that company about five years.

For many years Mr. Jackson was connected with the Trade Union, and at various times has held most of the branch offices. He joined the Lancashire Branch of the Institute of British Foundrymen in 1925. He is captain of the Accrington cricket club.

Publication Received.

Bradley's Magazine.—We are not sure whether this is to be a monthly publication or not. The issuing house, Messrs. Bradley & Foster, Limited, of Darlaston, Staffs, have printed No. 1 and November on its title page. However, we hope that this is the case, as it is the best edited publication of this character that we have encountered. Naturally, in the space of eight pages there is not much room for diversity of contents, yet there are two technical articles, one a *résumé* of Dietert's researches on gating and a second on cupola practice in the malleable-iron foundry. Then there is a page of news and views, whilst another contains a collection of smart jokes. Finally, there is a pig-iron price list and a page and half of advertisements. The firm have set themselves a high standard which we hope they will be able to maintain.

When drilling hardened steel, a good solution for lubricating drills can be made by dissolving a small quantity of camphor in a little alcohol and then mixing it with an equal volume of turpentine. The drill point should be kept wet with this solution.

Random Shots.

I saw with interest recently that the French are seriously asking themselves whether it would not be advantageous for them to have an ambassador of empire in the form of a Vice-President, to do for the Republic what the Prince of Wales does for Britain. You know, someone with charm of manner and poise and knowledge of the world and all that, who can be relied upon to do exactly the right thing and say the right thing at the right time. Or rather, perhaps, say and do what his hearers think is the right thing.

* * *

But perhaps it is not in the nature of things possible to have anything both ways. And surely we are entitled to have the incidental benefits of the constitutional system we enjoy. I venture to think that no Vice-President chosen by any system open to a nation could be expected to have the desired qualities.

* * *

It comes as a shock to find an institution which hasn't a Vice-President. Over here, where there is a President of anything, there always seems to be a quantity of Vice-Presidents.

* * *

Not all the things attributed to the Prince of Wales actually come from him, but this story deserves to be true, even if it isn't. Not being a gossip writer for the daily Press, I cannot pretend that I got it direct. He had had occasion to lunch with a very well-known public man, who has the reputation of being extremely pompous in his manner. Afterwards the Prince said to a friend that he now knew what it was like to be entertained by royalty.

* * *

A Fleet Street journalist has recently written a very severe diatribe on the daily Press and the way in which it vulgarises public taste. Among other things he criticises the gossip columns, and mentions that on his own showing the writer of the gossip column in a well-known London evening newspaper was educated at most of the leading public schools, as well as at Oxford, Cambridge, St. Andrews, and several foreign universities; that he has been attached to almost every British Embassy, and that he has more than once been in too widely separated places at the same time.

* * *

I would not so deceive you. For instance, I did not attend the recent complimentary dinner to Sir Henry Lytton, the Gilbert and Sullivan actor, but I can tell you a little story he told. Travelling on a long distance journey in Canada, he asked the negro porter what tip he usually got for one night and one day.

"Well, three dollars am my average," replied the darkie, who burst into ecstatic thanks when the three dollars was duly handed over. Lytton asked him why he was so enthusiastic.

"This am the first time my tip has come up to my average," he explained.

* * *

Here is a pretty little story from East Africa. A magistrate and his deputy were travelling, and broke the law by travelling during the night without a light. They agreed that justice could best be served by each appearing before the other. The magistrate, taking precedence, solemnly tried the deputy, and duly fined him five shillings. The deputy then tried the magistrate, and fined him fifty shillings, justifying his severity by pointing out that this was the second case of the kind tried that day, so that evidently the offence was becoming far too common!

Marksman.

A Reorganised Foundry Industry.

YORKSHIRE FOUNDERS' CLARION CALL.

The 1930-31 winter session of the West Yorkshire Branch of the Institute of British Foundrymen was opened at a meeting held on October 4 at the Bradford Technical College, when Mr. A. S. Worcester (Huddersfield), senior Vice-President, occupied the chair.

Profits Essential.

The President (Mr. H. Sayers, of Leeds), in his presidential address, said he was extremely sorry the 1930-31 session, and his own year of office, began in such lean times, and that the long-hoped-for trade revival seemed still to come. The most optimistic person, he supposed, must feel a wave of depression as he surveyed the conditions in industry to-day, both in this country and elsewhere. There was, no doubt, a good deal of excuse for people who found it hard to maintain interest in technical societies; yet the knowledge, help and co-operation to be obtained from the meetings were never so essential as now if one was to survive and succeed in business. Foundrymen might profitably devote, through their societies, a little time to problems which were by no means new, but for which no sound solution had yet been found. Such, for instance, as how to make money by making castings; how, in face of the competition of other materials, to retain old markets and capture new; and the problem of getting hold of lads of bright intellect for the service of the foundry trade. Some of these problems were perhaps more a matter of economics than technics, but, as the Institute's premier branch had lately turned its attention to the economics of the trade, they in West Yorkshire might also, without impropriety, say a few words on them. No matter how keen their interest in the technical aspect of the foundry, and in the pursuit of knowledge for its own sake, the financial aspect was particularly important at the present time, and the trade as a whole was at present a long way from solving the problem involved in that aspect.

Many of them might feel that, if they managed to make a living, they were doing all that could be expected, but Mr. Sayers maintained that that was insufficient. If the foundry was to survive as a separate entity, there must be a sufficient margin over running expenses to ensure the renewal of plant and buildings, to provide the necessary capital for taking advantage of new developments, and to stimulate research. To ensure this necessary modicum of profit there were two ways—to get more for the product, and/or to produce it more cheaply, and in the latter case not to pass on the whole of the saving to the ultimate owners of the goods.

The German Remedy.

The desirable thing, of course, said the speaker, was to combine the two ways—a higher price and a lower cost. That was no doubt difficult, but not impossible, and it had been done elsewhere. One of the chief sins in the foundry trade, suggested Mr. Sayers, was that of inefficient costing. They all knew of firms quoting impracticable prices for castings and getting the work to the detriment of themselves, their suppliers, their competitors and to the lowering of the standing of the whole industry. It was only fair to such people to suppose that they erred in ignorance—an ignorance which a simplified standardised costing system would enlighten. Systems were put forward from time to time, and their number probably confused the would-be student. What was needed was a scheme from a responsible body of foundrymen which could be used as a standard. At present there was no such body in England, and they had to go for an example to our late enemies, the Germans. The German Foundry Owners' Federation had gone most thoroughly into this matter, and published various memoranda. Whilst they admitted these were not perfect, they had undoubtedly done a great deal of good. To quote the German Federation's President, Dr. Werner: "These memoranda have caused all other methods of costing to disappear in German foundries." Further, the German attempts to ensure that castings should only be sold at a fair price had met with considerable success. Dr. Werner, speaking before the London Branch on March 20 last, made the statement that the German foundrymen had been enabled by their efforts to obtain much better prices than they had done two years ago. In England the reverse was the case.

The German Federation also advised more specialisation among foundries; to quote only for those castings for which they were best equipped, and to take no job at a losing price in the hope of making up on something else—an immoral proceeding which generally failed of its object.

Desirable Equipment Unobtainable.

Turning to the subject of more economical production, Mr. Sayers remarked that inventors of foundry machinery were continually offering improved products for the use of the industry, and it was a great pity that under present conditions fuller advantage could not be taken of their enterprise; but to justify the laying out of capital in that direction a visible market was needed, and this at present was non-existent, and until there were better signs the industry would perhaps have to seek economy in other directions; for instance, in standardisation of materials. They should be able to buy with negligible variations standard qualities of coke, ganister, iron, sand, blacking and the numerous other foundry raw material, variations in which were a frequent cause of trouble and loss. In methods of moulding much might be done by discussion and co-operation. The German Federation had made great progress in recording from actual practice the most economical methods of moulding castings of standard design. These records were at the service of their members, and the general following of these methods tended to a standardisation of costs.

The Object Sought.

To sum up, the way to make money from foundry work was first to know what the castings cost, then sell them at a fair margin of profit; second, endeavour to reduce the cost by careful buying of the correct materials, tackling only those jobs for which the shop was equipped, thinking out and adopting the most efficient methods; and, lastly, getting the work. Then there came the problem of regaining and retaining markets. During the past few years the foundrymen's market had been seriously invaded and reduced by the competition of pressed and fabricated steel shapes. To set against this, they had the increasing demand for castings for explosive and crude-oil engines, but as these types of engine competed with the steam engine and were taking its place the foundry industry had to discount a good deal of the increase on that score. The menace of the fabricated shape grew steadily more serious. Mr. Sayers was of opinion that this type of thing owed its inception to the lack of shock resistance in iron, a quality in which commercial metal was notoriously weak. He believed the Lanz process was the only one which made any claim greatly to improve cast iron in that respect, but that process involved considerable trouble in transporting and heating moulds. Trouble meant expense, thus losing much of the economic advantage possessed by cast iron. What was needed, he thought, was a method by which one would be able to tap from the cupola or other furnace a metal which should be tough while losing none of the other advantages of cast iron—an ideal difficult to attain, he admitted; yet he believed a very considerable improvement was possible in commercial cast iron, in this quality of shock resistance, and felt it was a subject which would well repay time and cost spent in research. Most foundrymen had, in their time, made—perhaps by accident—a batch of metal which had at least twice the toughness of ordinary casts. In the shop where the speaker had served his time they occasionally ran a mixture of hematite, Scotch and foundry scrap for casting into light rectangular frames into which type was wedged for use in printing. At times they got a metal of abnormal toughness and resilience, but not always—due to some unknown factor—so that its use was gradually discontinued and replaced by the use of steel, and that market was lost. The metal at its best was quite good enough, but the conditions were not sufficiently understood to enable its production to be guaranteed. Again, when making special iron in the cupola, in pig of a similar composition an enormous difference was found in toughness between the metal made at the beginning of the blow and that at the end—the latter being always the tougher. Sir Harold Carpenter, in his search for a non-growing metal, developed an iron which he said was tough and not unlike malleable. The composition was T.C. 2.6 per cent., Si 0.6, Mn 1.6, S 1 and P 0.05 per cent., a difficult composition to get from the cupola, but one never knew what one could do until one tried. These were slight indications of the lines on which research might proceed in the quest for a tough iron melted in the cupola or other furnace which could compete with the fabricated shape.

Recruitment and Staffing.

The supply and education of craftsmen, foremen, managers and metallurgists, etc., was a matter of great importance to the future of the trade, suggested the President. At the recent convention Dr. Ingall had made the statement that the class of foundry employee was definitely inferior—presumably he meant mentally—to the class employed in boiler making, fitting, etc. This was a very humiliating statement for those who were, or had been, foundry employees, to hear. They could only hope it was not correct at the time they themselves were recruited to the industry. There was a fear of a shortage of skilled craftsmen in the foundry. At the same time there was a shortage of openings for boys leaving school. In spite of these two facts it seemed very difficult to get intelligent lads to enter the foundry. Obviously that was the first thing to be tackled before they could be trained. The supply and quality of the personnel in any occupation was regulated by the conditions of service, the potential rewards and the prestige which that occupation enjoyed. It followed that any occupation—founding included—received the personnel which it deserved. Mr. Sayers was of the opinion that the best thing that could happen to the foundry trade was for there to be a real shortage of good craftsmen. Only then would the importance of the foundryman be realised, as the foundation of the engineering trade and of modern civilisation.

American Idealism.

One speaker had said that the welfare and uplift schemes of which the United States engineering organisations were so prolific were initiated with the object of attracting a higher class of youth into those occupations. When it was possible for the foundry employee to go from his work and ride in a public conveyance without being an eyesore, and when the rewards to the really capable craftsman were such as to compare favourably with those in less arduous occupations, then the foundry would stand a better chance of getting its share of the intelligent and adventurous among the lads who were starting

out in life, and, having got them, engage upon their training. The best training, in Mr. Sayers' opinion, was to be had in a shop doing a general line of work and in this type of shop setting them to work with various good men on a variety of jobs. Thus were the first-class craftsmen of the past and present trained. One might be told that this type of shop was passing. That was true to a certain extent, and so was the need for the old-time craftsman also passing to a certain extent, though there were signs of a revolt against the increase of mass production and the continual lessening of the amount of labour employed in proportion to output. A time was coming, or had come, when a decrease in the labour employed meant a decrease in the market for goods. Without going far into such debatable ground, he (Mr. Sayers) was of opinion that there would always remain a sufficiency of general shops in which to train the needed craftsmen, provided it was worth while for their owners to bother with them. One visualised an association of foundrymen who, having in mind the needs of the trade, should establish a fund out of which any firm should receive a premium for every lad of their training who passed the association's examination. From the more able and ambitious of these candidates would the future executive officers of the trade be drawn, and in their future training take advantage of the facilities which municipal education authorities were so eager to afford.

The Answer.

In conclusion, Mr. Sayers drew attention to Dr. Werner's Paper given before the London Branch of the Institute on March 20 and published in The Foundry Trade Journal of April 10 and 17. The most striking feature of the Paper was the indication of the services rendered to the foundry trade by the German Federation—constructive services such as the co-ordination of the latest knowledge of metallurgy; preparation of materials; standardised costing; methods of moulding; preparation of tackle, etc. The whole thing was of such value that, to quote Dr. Werner's own statement, nothing was feared by the members of the Federation so much as the possibility of expulsion from its ranks. This position, obviously, gave them great power over the wrongdoer. It was most desirable that there should be a similar body in England who could deal in equally efficient fashion with the problems of the trade. They, as an Institute, were not a commercial body, but a scientific one, representing—as Mr. Wilson had most happily put it—a vertical section of the whole foundry trade from apprenticeship to owner, and as such they could not initiate the required reforms, but could only criticise and advise.

On the motion of Mr. J. J. Watson (Huddersfield), seconded by Mr. W. G. Thornton, Mr. Sayers was heartily thanked for his address.

Book Review.

Workshop Practice, Vols. 1 to 8. Edited by E. A. Atkins, M.I.Mech.E. Published by Sir Isaac Pitman & Sons, Limited, Parker Street, Kingsway, London, W.C.2. Price 6s. per volume.

We know of no collection of books which, though elementary, gives a specialised engineer, metallurgist or foundryman an insight into related activities in such an easily assimilated manner. The matter is reliable and covers information likely to be wanted by those in charge of shops when called upon to deal with matters which are not of the usual routine character.

Volume I covers hand-tools, calculations and formulæ, drawing and sketching, non-ferrous metals and cast iron and wrought iron, the last-named section being a really well-balanced introduction to cast-ferrous metallurgy.

The whole of Volume II is devoted to pattern-making and foundry work. The pattern-making and core-box sections form an excellent course of study for the student, but that devoted to iron and steel founding suffers from a poor choice of illustrations. The cupola shown is of foreign design, virtually unknown outside its country of origin. One was installed in Scotland some years ago, but has now been changed over to the Poumay system. The crucible and electric furnaces will pass muster, but why illustrate a Stock converter instead of the much more popular side-blown baby converter? Similarly, the choice of illustrations for moulding machines could be more representative. The sand slinger which is described could usefully have been illustrated, as it is difficult for a neophyte to visualise its appearance from the printed story. Insufficient space is devoted to the fettling shop.

Volume III has three sections: the steels, hardening and tempering, and lathes, shaping and planing machines. It seems curious, but people who write books do not seem yet to have realised that, except for "baby" vessels, the Bessemer process no longer exists in Great Britain. However, as its product as made on the Continent competes with the home-made article, we suppose there is more reason than ever why the student should know of its underlying principles. The later portion of this section ought to contain a table of compositions of steels and their uses. It would make Table I on page 628 (Hardening section) much more illuminating. Instead of this, the suggested information comes in on page 632.

Volume IV takes the student through the subjects of drilling, grinding, slotting, milling, and the machines used, jigs and tools and turret and automatic lathes. To forging and die making the editor has devoted Volume V. Malleable founders would do well to study the section on drop forging, as a profound knowledge of a competitive method may reveal, commercially, exploitable weaknesses.

The processes connected with sheet-metal working, gear cutting, wire and tube manufacture are detailed in Volume VI. We are of opinion that, say, wire manufacture or some other section in this volume could usefully have been replaced by welding, as being of more general interest to the engineering and allied trades.

In Volume VII, bearings, both plain, ball and roller, are dealt with, as well as petrol engines and gas-engine fitting and assembly. It contains just the sort of information desired by a large number of foundry foremen when reorganising their shops and carrying through the work themselves.

A study of Volume VIII, which covers engine fitting and erection by the foundry staff, will help them to appreciate better the result of their handicraft. The matter is written in simple language and is quite easy to follow by those who are constantly brought in contact with engineering castings.

The whole work contains 1,008 pages, and for indexing each section has been isolated and placed at the end of its appropriate volume. The illustrations vary a little, but, in general, are excellent. The editor obviously shares our preference for line drawings as being in general of greater utility than photographs; but even editors cannot always get their own way!

As a means of securing a working knowledge of engineering work allied to one's own, we can thoroughly recommend this series.

To detect cracks on a machined surface, first clean it and then paint it with a thin mixture of petrol and red lead. The petrol will soon evaporate, and the remaining red lead should be wiped off. The surface should then be examined through a magnifying glass, and if a crack exists it will be shown up by a red streak on the surface, this being the red lead which has worked into the crack, and was therefore not wiped off.

Copper Scrap is Cheap.

By "Onlooker."

For the early part of the year, when the price of electro copper as quoted by the Exporters' Association was £84 per ton, standard copper registered a wide differential, and best select brands were relatively cheap. Scrap, too, was selling at almost unheard-of margins, heavy copper scrap being quoted at as much as £12 and £14 below the wire-bar price, while brass scrap showed a very comfortable margin on the mixture value. No sooner was the cut of £18 made in April than these attractive differentials were wiped out, and for a time old metals looked dear, but a fairly speedy adjustment was made to reasonable levels. Since that time copper has declined in value with hardly a check, and although scrap prices have naturally come down, too, their fall, particularly since the price of electro got down into the fifties, has been reluctant in the extreme.

When the price of refined copper broke £60 hoarding of old metals began quite definitely, for holders had it in mind that a recovery was certain, and they preferred to keep their stuff in the hope that a turn would come. That is one reason why old metals have been scarce, but another reason is the fact that at these extremely low figures collection is hardly a paying proposition to the "junk man." Generally speaking, reserves of scrap in Europe at the present time (apart from material held by the various Governments) are very low, and many dealers are finding that they cannot secure sufficient stuff to complete contracts entered into some weeks ago at procurable prices. In America the case is probably rather different, and there is some reason to suppose that across the Atlantic old metals have been accumulating. For many weeks now it has been almost impossible to buy brass scrap in the States at reasonable prices, and as a result shipments to Europe have been on a much reduced scale. It is, of course, only right to say that owing to bad trade no great call has been made from this side for old metals, and even when bids have gone out fears of a further decline in copper have kept those offers low, but domestic users in the States have found it difficult to secure much old material.

When copper got down to 9½ cents in New York and wire bars on the London Metal Exchange stood at £45 5s., scrap gave way slightly, but for the most part prices were maintained at a level high by comparison with the cost of virgin metals. For all that, it is possible to buy old metals cheaper than most people can ever remember, and as it is fairly evident that at 9½ cents the fall in copper was overdone, it is not surprising that consumers have shown keenness to buy fairly extensively. No doubt purchasing would have been on an even larger scale had manufacturers felt that orders from their customers were going to accrue, but unfortunately of that there has been no certainty. Scrap may be said at the present time to be cheap actually, if not relatively, and there is very little chance at present of any improvement in the latter degree, for supplies will be scarce for some long time to come, and this cannot fail to reduce the margin below new metals. It is somewhat curious that consumers are very slow to realise the cheapness of virgin metals, or, to put it another way, they seem to find it impossible to believe that virgin copper and spelter can ever take the place of scrap. To those who view the old metal market as a place of actual values and not relative, prices such as obtained during the latter part of October could hardly fail to be attractive. Copper scrap fell as low as £40, and scrap shell-cases of first-class cartridge quality were marked down to little over £35 per ton.

It is notorious that the man who gets in at the bottom must consider himself lucky. Recent events in the world of old metals have proved this truth conclusively.

Creep Limit of Cast Steel at Elevated Temperatures.

For the determination of creep three methods are adopted:—(1) Experiments with constant rate of loading at constant temperature. The slower the rate of loading the lower is the ultimate tensile strength. Such experiments if conducted until fracture occurs require a rather long period of time, because the rate of loading must be sufficiently slow that the determined strength is not too much above the real creep limit.

(2) Experiments with constant load and varying temperature. An apparatus for such experiments has been designed by W. Rohn some time ago. The loaded test piece is in an electrically-heated furnace; by the creep of the test piece a contact is operated which throws off the current whereby the temperature of the furnace decreases. After some time the current is switched on again. By alternating throwing off and on the current the temperature of the furnace gradually decreases until no creep of the test piece occurs, and the contact is no longer operated. The load of the test piece is the creep limit at the ultimate temperature.

(3) Experiments with constant load and constant temperature. Such experiments if conducted until fracture occurs also require a pretty long period of time. However, with the abridged method, according to A. Pomp and A. Dahmen, the creep limit can be determined with a sufficient degree of accuracy by examining the rate of elongation. Under constant load the test piece elongates at first elastically; then the elastic after-effect occurs, and the test piece continues to elongate plastically. Under a small load the permanent elongation finally ceases, or the changes in length will be so small that they cannot be measured even after long periods of time. In Fig. 1 a sketch of the time-elongation

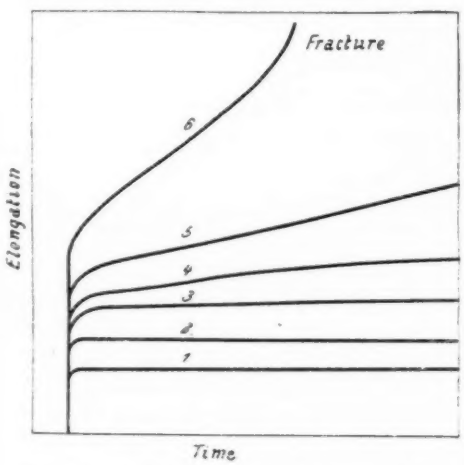

Fig. 1.—Time-Elongation Diagram (Pomp and Dahmen).

curves, according to A. Pomp and A. Dahmen, is shown. The curves 1 and 2 represent the rate of elongation under very small loads. Shortly after applying the load an appreciable elongation occurs which, however, ceases nearly at once with load 1, and a little later with load 2. By further increasing the load curve 3 results, which does not take a course parallel to the abscissa, but after some time. With the loads 4 and 5 the test piece continues to elongate within the experimental time. Curve 6 represents the rate of elongation under a very high load, which results in breaking the test piece. According to A. Pomp and A. Dahmen, the creep limit is represented by the load which causes a permanent elongation of 0.001 per cent. per hour during the fourth to the sixth hour of the experimental time.

With the aid of the abridged method experiments were made by A. Thum and H. Holdt.* A sketch of the testing apparatus used is given in Fig. 2. The load is applied to the test piece by means of a lever the ratio of which is 1 : 100. The furnace for heating the test piece is fastened to the upper support. The top of the furnace is firmly closed, the bottom is covered with an asbestos plate. The upper support with the furnace and the lever with the scale are brought into balance with the aid of the sliding weight A. With the exception of the first hours of the experiments a readjustment of the apparatus by means of the bevel-wheel drive B is not necessary, but within long periods of time. The test piece is heated in air, as salt baths of high temperature corrode the measuring device. The temperature is measured by a nickel, nickel-chromium thermocouple fastened to the middle of the test piece. Preliminary experiments showed that the temperature gradient over the gauge length was not greater than 1 deg. C., and that the temperature difference between the interior and the surface of the test piece was within the errors of observation. The fluctuations of the furnace temperature were not greater than 0.5 deg. C. The elongation of the test piece was measured by means of the Martens mirror extensometer.

Two kinds of steel were examined. The chemical compositions and the strength properties at room temperature are recorded in Table I. The ingots were annealed at 920 deg. C. for about 10 hours. The microstructures of the heat-treated ingots are shown in Figs. 3 and 4. For the most part the pearlite is lamellar and forms a network. The test pieces cut from the ingots had a diameter of 12 mm. (0.472 in.) and a gauge length of 75 mm. (2.95 in.).

At the beginning of the investigation the tests were conducted in the following manner. A small load which probably was below the creep limit was applied to the test piece, and a time-elongation diagram was taken. Then the load was increased and the rate of elongation was determined again. Increasing the load was continued until the rate of elongation during the 4th to the 6th hour was 0.001 per cent. per hour or over. In the latter case the creep limit was determined by graphic interpolation of the curves, representing the rate of elongation just below and above 0.001 per cent. per hour. Observations, however, showed that it is not indifferent whether the creep limit is determined by applying the load in several stages or by subjecting the test piece to the full load from the beginning. In the former case an appreciably higher creep limit can be obtained, due to the work-hardening effect, and especially if the test be conducted over a longer period of time than 6 hours, as required by the abridged method. In the case the available quantity of material is limited, and the load must be applied in several stages, it is, therefore, recommendable not to exceed the period of 6 hours. A noticeable error does not result when the load is applied in two stages, the first load being below the second above the creep limit. The possible deviations from the real creep limit due to loading in stages are recorded in Table II.

* "Die Giesserei," 1930, No. 17.

Table I.

Steel.	Chemical composition.					Stretch limit.	Ultimate tensile strength.	Elongation.	Contraction of area.	Notched bar impact strength.*		Fatigue strength.†
	C	Mn	Si	P	S							
No.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Tons per sq. in.	Tons per sq. in.	Per cent.	Per cent.	Mkg. cm^{-2}.	Ft.-lbs.	Tons per sq. in.
A	0.2	0.72	0.27	0.04	0.03	upper 21.0 lower 20.3	31.1	26.9	50.9	7.3	42.2	13.3
B	0.36	0.79	0.33	0.04	0.03	22.0	35.6	27.0	37.7	4.4	25.4	14.6

* Determined with the test piece of the International Soc. for Test. Mat. Total cross-section area 10 by 10 mm., diameter of notch 2 mm., depth of notch 5 mm. The values given in ft.-lbs. refer to a testing area of 10 by 8 mm., corresponding to that of the Izod test piece.
† Transverse strength without failure within 10,000,000 reversals of stress; tests were made with the bending machine by C. Schenck.

Table II.

		Loaded in 4 stages.	Loaded in 3 stages.	Separate test piece for each load.
Steel A (500 deg. C.)	Creep limit, tons per sq. in.	4.70	4.57	4.28
	Deviation, per cent.	10	7	—
Steel B (500 deg. C.)	Creep limit, tons per sq. in.	4.00	3.87	3.75
	Deviation, per cent.	7	3	—

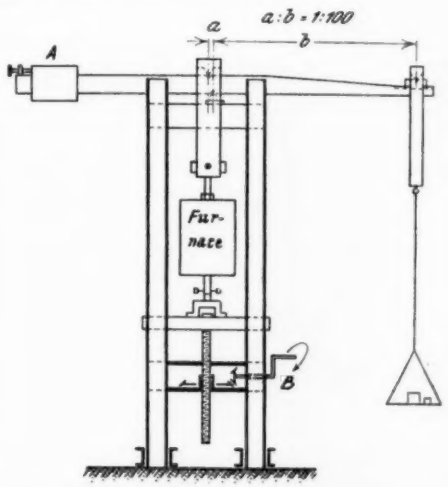

Fig. 2.—Creep-Limit Testing Machine.

The values for the creep limit of the two steels at various temperatures as determined by the abridged method are recorded in Table III. For comparison the strength properties as revealed

by a short-time tensile test are added. The values for the elastic limit largely depend on how long the different stages of load are applied to the test piece. In the present experiments each stage was applied for about 30 sec. In order to get reliable data the elastic limit was taken as the stress which causes a permanent elongation of 0.01 per cent. instead of 0.001 per cent. The stretch limit was well-defined up to 300 deg. C. At higher temperatures it was taken from the stress-strain diagram as the stress corresponding to the point of deviation from the straight line. The stretch limit gradually decreases with the increasing temperature. The ultimate strength somewhat decreases just above room temperature, and shows a slight maximum value at between 200 and 300 deg. C. Then it rapidly decreases in a much higher degree than the stretch limit. Elongation and contraction of area show about the opposite behaviour, with a well-defined minimum value at 400 deg. C.

Table III.

Steel.	Temp.	Elastic limit.	Stretch limit.	Tensile strength.	Elongation.	Contraction of area.	Creep limit.
No.	Deg. C.	Tons per sq. in.	Tons per sq. in.	Tons per sq. in.	Per cent.	Per cent.	Tons per sq. in.
A	20	12.95	up. 21.0 low. 20.3	31.1	26.9	50.9	—
	—	—	—	—	—	—	—
	100	11.87	19.4	28.1	28.5	57.1	—
	200	7.93	17.5	29.0	26.0	47.0	10.98
	300	6.66	15.8	27.1	18.5	29.5	9.91
	400	5.91	14.5	26.3	15.6	13.5	6.86
	500	2.35	9.5	18.8	16.9	18.85	4.28
	600	0.32	6.8	10.0	20.9	19.35	0.89
B	20	—	22.0	35.6	25.1	37.7	—
	100	—	19.5	33.4	25.7	40.45	—
	200	—	17.4	32.8	22.95	29.35	14.53
	300	—	15.3	33.9	18.9	17.85	10.35
	400	—	15.5	29.5	13.7	12.75	7.05
	500	—	10.0	21.3	17.1	19.35	3.75
	600	—	7.5	12.5	17.4	19.55	0.70

The creep limit is noticeable below the strength limit already at 200 deg. C. With the exception of the temperature rate between 200 and 300 deg. C. the values of the two steels decrease in the same degree. In spite of the higher carbon content steel B shows a creep limit which at 300 and 400 deg. C. is only a little higher and above 400 deg. C. somewhat lower than that of steel A. No explanation for this behaviour was given by the metallographic examination. The small amount of granular pearlite was about the same with both samples; the shapes of the ferrite grains, too, were the same.

In order to determine the effect of the microstructure upon the creep limit the two steels were re-annealed at 875 deg. C. for half an hour. By this treatment a very fine-grained structure was obtained, with a regular distribution of the pearlite, as shown by the Figs. 5 and 6. With these samples the creep limit was determined at 500 deg. C. and was found to be lower than before, being 3.37 tons per sq. in. with steel A and 3.24 tons per sq. in. with steel B. An explanation for this behaviour cannot yet be given. To all appearance the pearlite network obtained with long annealing periods increases the sliding friction at high temperatures by surrounding the soft ferrite grains, thus rendering the flow of metal more difficult.

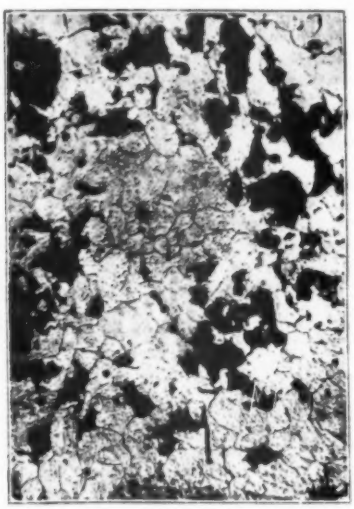

Fig. 3.—Steel A, annealed at 920 deg. C. for 10 hrs. × 200.

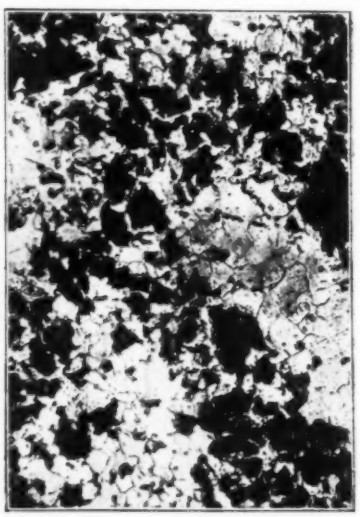

Fig. 4.—Steel B, annealed at 920 deg. C. for 10 hrs. × 200.

Fig. 5.—Steel A, re-annealed at 875 deg. C. for ½ hr. × 200.

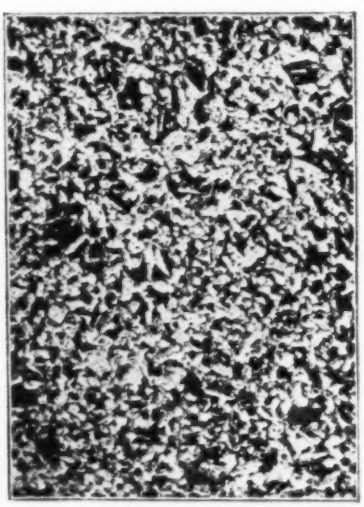

Fig. 6.—Steel B, re-annealed at 875 deg. C. for ½ hr. × 200.

Safety Lay-out for Emptying Cupolas.

The South German Union of Iron & Steel Industries in 1929 organised a competition for eliminating or reducing the danger from projections and explosions to be associated with the dropping of cupola bottoms after a day's run. An arrangement designed by Karl Lehmann won the first prize.

His proposal is shown in Figs. 1 and 2. Two semi-circular grooves in the two halves of the drop-bottom of a cupola carry a central opening under the hearth. This opening is closed by a plate, maintained in position by two wedges. The plate carries a finger, centrally positioned and pointing upwards, which penetrates the sand hearth almost to its surface.

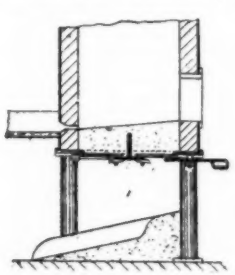

Fig. 1.

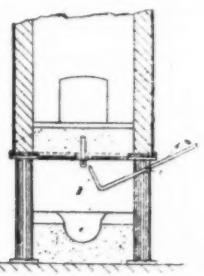

Fig. 2.

When the time arrives for dropping the bottom, old sand is placed between the columns of the cupola and a channel is formed towards the front of the furnace, and at the end of this channel a basin is made for the reception of any slag and metal remaining in the cupola.

This done, by means of a hook-bar, the two wedges are withdrawn and the central plate is removed, the finger of which leaves a hole in the sand hearth. Then with a hooked-pricker bar, utilising a bearing attached to one of the columns as a fulcrum, the hearth is pierced. The slag and metal flow freely and easily into the channel and so into the basin. The flow having ceased, it only remains to open the drop-bottom in the usual way.

The Human Factor in the Jobbing Foundry.

CRAFTSMANSHIP AND EDUCATION DISCUSSED.

Several problems with regard to the foundry industry were discussed by the members of the East Midlands Branch of the Institute of British Foundrymen at the College of Technology, Leicester, on Saturday evening, October 25. Mr. T. Goodwin presided, and the towns represented included Derby, Leicester, Nottingham, Syston and Loughborough.

The principal guest was Mr. A. S. Worcester, of Huddersfield, who, at one time, was a member of the East Midlands Branch, and Mr. T. Goodwin, in extending a welcome, said how pleased the members were to have Mr. Worcester to top the bill in their discussion on "The Human Factor in the Jobbing Foundry." It was one of the most interesting of subjects in connection with the industry.

MR. WORCESTER said they still had a large number of jobbing foundries, and embraced under the heading of the subject were most of the large engineering foundries where quantities would not allow of running on repetition lines. In that class of shop the human factor, in his opinion, was the largest one. The skilled labour time was the basis of all estimating and costing in such a class of foundry. Only those that had to give a time for a job or price could realise how far their estimates could go awry when the job reached the moulder and coremaker. The difference in time for the same or smaller jobs was sometimes alarming. There were probably three headings under which they could start to analyse—craftsmanship, tackle and materials. The most important was the first. It seemed to be generally accepted that craftsmanship in the foundry was not on as high a plane as they could wish. The Institute had done much for it and it would do still more.

The best craftsman, he said, was the one who knew how to produce a good casting with the minimum of labour and materials. The craftsman who put in the most labour and time, invariably used most material, particularly stakes, lifters, sprigs, facing and blacking. The scrap heap was a good object-lesson. How many castings were scrap through too hard-rammed bottoms, too much sleeking of the face, too much plumbago, too many lifters in the top, not allowing it to be rammed evenly, too many sprigs in the face pushed in after venting and incidentally closing all the vents? The jobbing-foundry foreman had got to get down to details of craftsman, he said. They must insist on some sort of regular practice. Why allow three 4-in. when two 6-in. rams will do? Why vent twice or more when once will do? Why a lifter every 2 in. when a 4-in. space will suffice? Why spoil the face of a mould with the needle wire? Why run small tools over the face of the mould when the shape is best as the pattern has left it? Why smooth a dry-sand heavy job and then sleek the blacking? Or, as he had seen in Nottingham, why join cores when they will lay flat on their joints? Those were all points that could be established in any jobbing foundry and help to keep the human factor under some control.

Craftsmen Limited in Knowledge.

They could not, he said, lose sight of the fact that craftsmen were limited in their knowledge by the experience they had received and the simile "horses for courses" applied. Light and heavy green sand and light and heavy dry sand and loam were the usual divisions. Light green-sand work was best without plumbago or blacking faces, but the moulder loved a dusting of plumbago and often a little parting powder. A good bonded sand was necessary where the runner hit the mould. The heavy green sand was the class of work that called for the best craftsmen and supervision. Loam moulders will dispute this, but theirs is a safer job altogether. However, they could for instance assume that a good facing sand, open and with coarse coal dust, was delivered to the moulder. The two chief points the moulder had to bear in mind were, firstly, to get away from the face the gases from coal dust and steam, for the sand must be moist enough to hold together; secondly, they must get the bottom solid enough to stand the pressure of the fluid metal. The methods of getting the gases away were very often a long way from logical. The natural laws operated—taking the lines of least resistance. One could see daily the easier way had been through the metal via runner, or more frequently the riser, and more often still a scab, particularly over a cod or pocket, indicated where a sort of fight had been waged until the heat of the metal had won and sent the gases the other way. They found then that the face had broken somewhere, and the general luck of the founder was that it was where it was not wanted. They could, for instance, take an ordinary cod or pocket of sand, vent and sprig it, and get a good scab.

They should ram it fairly hard up to the face, and then introduce a large vent wire about $\frac{1}{4}$ in. with a knot on it and give a liberal venting. They should then close the tops of the vents, use small wire on the face, and, lastly, they should sprig all over. The obvious result was that the large vent wire had made it so hard that the metal would not lie on it. The vents had probably brought the gases up to the face under pressure, and the sprigs further hardened it and closed any possible vents. It should always be made quite sure in heavy green sand to have an outlet for any vents put in. Many founders would say that lifters would bring the air up from a top cod, but a few vents would do it much better. The easiest way to produce a scab, he believed, was to moisten the face of the mould by sprinkling with water and sleek with a trowel before the water soaked in. Small projections suffered very much from this.

The human element lets the management down badly. Moulders did not ram the bottoms on heavy green sand hard enough. Invariably the moulder stuck to the peg rammer for any width of sand, yet the flat rammer was a much better tool for wide stretches—but not used to make a heavy top. Two blows in the same spot every six inches would ram solidly and save energy. When bedding in, it was better to lift a pattern once or twice than trust to a soft spot being hard enough. In that class of work more than any, it paid to do without disturbing the face of the mould as much as possible after the pattern was drawn. The highest skilled moulder with good tools could not make the shape as good as the pattern left it.

Producing a Good Casting.

Dry sand was, perhaps, best divided into two sections—light and heavy. Provided a foundry was equipped with adequate stove room and easy handling, light dry-sand work could be produced as cheaply as green sand and the casting would have a much better appearance. Many, no doubt, would disagree with him in that, but that was his opinion. The craftsmen, of course, must not treat it as a green-sand job. The ordinary green-sand facing, but wetter and a light coat of blacking sprayed on if they had compressed air, would do the job. The craftsmen must understand that the moisture would be driven off in stoving, and very litte venting was necessary. The same applied in ramming, yet nowhere near the care was necessary.

The heavy dry-sand craftsmen seemed scarce in the jobbing foundries, and to "unlearn" some of the green-sand moulders was troublesome. Crushing joints, lack of blacking, rounded corners and tears of thick blacking were the usual results of green-sand moulders' efforts. They need not be afraid of the water pot. Joints, well watered and pressed down to just below the pattern, would leave a hard joint and a clearance from crushing. Probably the old saying, "a $\frac{1}{4}$ in. of flash is better than $\frac{1}{16}$ in. crush," still held good. The upright surfaces of a dry-sand mould nearly always suffered from a lack of blacking, and the flat surfaces received more than their share. A good dry-sand moulder would rough-finish his mould, give a level, heavy coat of blacking and sleek up in less time than many could get a thin coat on in other places. It was a good plan to give the joint a coat of blacking. The sleeking of wet blacking seemed to the uninitiated a work of art. There was really nothing in it beyond a tool with a square edge, and to work with the edge and leave the blacking on. The human factor in loam moulding was, perhaps, more varied than in any branch. The craftsman who could visualise his job from the putting down of his bottom plate to the metal coming up to the riser, from his boards and drawings, was the most successful.

Perhaps the most important and inseparable from the job itself was the tackle. Bottom plates were best with a square handle. Personally, he had found them to have adequate strength with the minimum of weight and to withstand the heating up in the stove. A third of the area was best left out of the centre and made up with a loose plate. The square handle was very useful in adjusting the chains for picking up level. The handles of top plates were best square, but kept in a straight line on the outsides for turning on baulks. The lugs on loam plates were rarely what they might be and should certainly be undercut. A three-cornered prong was most serviceable.

Running of Castings.

Another important point, so far as the human element was concerned, was the running of castings. The jobbing founder had to treat each job as a separate entity, but a few points might be observed. Getting a clean casting was the great consideration. The scum was lighter than the metal, and, working with that in mind, clean metal could be got into a mould. The running of an open box part was a good object lesson in running.

The human factor showed up very clearly in the tackle of the jobbing shop. Many foundrymen had, no doubt, learned much from the tackle left by their predecessors. The various foremen and managers usually had some peculiarities. One of the best class of craftsmen were the pattern-plate makers. In the jobbing foundry they could not afford the elaborate plates of the repetition shop, and good plate makers were scarce. A frame was a good, cheap method. A useful box, up to 18 in. square, could be made with a block pattern, rounded corners, ribbed inside for loose pins or a tapped hole for holding a fast pin. The steel box, of course, was best, but did anyone know of a preservative? Personally, he found loose pins quite good so long as the holes were in the thick lug close together. In jobbing shops it paid to keep bars clear of the centre of boxes in both bottom and tops, as it allowed for bosses or a spindle. For the larger boxes a loose grid was better than a bottom part. Many of the large tops, even when split at the corner, were weakened by the outsides being thicker than the bars. Bearing the outside as soon as cast would eliminate that trouble. The building up of a number of middle parts to allow for a long pin for a deep lift was a problem. Personally he had adopted the method of pin-size holes at cross corners and a bush to make up when required, but he asked if anyone had any better suggestion.

What could they do to uplift and interest the

craftsmen? The present methods, he thought, rather made experts and specialists. The Institute had done far more to make specialists in the way of producing foundry managers and foremen than it had to uplift the whole craft. This year he himself had made an effort to get the Huddersfield Technical College to start a class for foundry students, and the young men in the foundry, as well as the apprentices, were attending, and appeared to be well satisfied.

DISCUSSION.

Mr. E. Stevenson (Nottingham) said that Mr. Worcester had certainly raised a number of interesting points, and so far as the green-sand and dry-sand men were concerned he could not agree. He had said that a green-sand man could not make dry-sand moulds. Actually, the reverse was the truth. He had had experience, and the result was that the dry-sand moulder had made one of the finest colonies of scabs on a green-sand casting he had ever seen. Speaking with regard to the moulding boxes, he asked, amid laughter, if they could find anyone who could drill them accurately. A sixty-fourth of an inch was far too much. The allowance he made between the hole and the pin was 1,000th of an inch, and that was all, but as he had not been able to find any engineer in Nottingham who was capable of drilling correctly he had abolished the system altogether, and now they cast their boxes on an oil-sand cake—a dead flat one. With regard to apprentices and their education, it had been suggested that the first three-years' course should be for foundry work, chemistry and machine drawing, but he suggested instead reading, writing and arithmetic. The average apprentice was incapable of making any calculation at all in chemistry. They required a good knowledge of figures and decimals. In machine drawing they should know what 1½ and 1¾ in. made when added together.

He thought that foundry apprentices from the ages of 16 to 17 should be encouraged to attend night schools and learn reading, writing and arithmetic, subjects they ought to have learned at the day schools, before tackling the foundry problem. If they did that they would get on much better than they did to-day.

Mr. Worcester said that in Leicester between 80 and 90 joined the classes, and at the end of four years they could only trace about eight lads who had continued in the foundry.

Use of Water.

Mr. J. C. Hallamore (Derby) said it had been stated the castings would scab, but he did not think a reasonable quantity of water would hurt.

Mr. Worcester, in reply, said that, with regard to patterns, 30 per cent. of those used by him could not be termed patterns at all. With regard to the use of water, he believed that in the Black Country they could not produce without some water being used.

Present Trend of Foundry Courses.

Mr. P. A. Russell (Leicester) said he believed the present trend of the Education authorities was to insist on a two-years' course at an evening school for reading, writing and arithmetic before taking up foundry-practice classes. He confessed it was very difficult to get the lads to do it, but he thought it was certainly worth while running a special class. There were a good many moulders who thought more about arithmetic than they were given credit for. With regard to dry-sand moulding, he mentioned that he had dried some jobs which would have caused moulders of 25 years ago to have a fit. By increasing their drying work there was a tendency to lose craftsmen. Mr. Worcester had said that the heavy green-sand moulder was the best craftsman. Personally, he agreed that the green-sand moulder did not utilise the best methods in making a green-sand mould. Economic conditions were forcing the industry to go in for dry sand. He had had some steel moulding boxes in use for ten years. They had given good service, but now it was time something was done with them.

Steel Moulding Boxes.

Mr. Worcester said, so far as runners were concerned, it was a matter of speed. There was a certain amount of time that passed before the down runner caught up with the cross runner to allow the box to fill. The idea of putting one runner at the top and a connecting runner in the middle was to prevent any liquid metal passing out of it before it was full. Until it was full a runner could not function. When full, it had trapped the scum, and the metal passed underneath. With regard to moulding-box clearances, he agreed it was a vexed question; rust was the biggest bugbear.

Mr. E. Stevenson said that the 1,000th-inch clearance only applied to the interchangeable boxes worked with loose pins. It did not apply to boxes with fast pins. He was eliminating as far as possible all fast pins.

Mr. Worcester said that, with a 64th-inch clearance, there was a movement, but it was hardly noticeable.

Controlling Factors in Casting.

Mr. W. Pyatt (Leicester) said he thought some of the failures were due to lack of knowledge or to lack of teaching. So far as vents were concerned, this was very often overdone. How many of the average moulders knew, when they were venting, why they were doing so, or why it was necessary? Thousands of vents were put in moulds that were not necessary. With regard to gates, he had been very much interested in the subject in the past, because he was of the opinion they were a controlling factor in castings. Mr. Worcester had mentioned that he had invariably seen in-gates much larger than the down gates. He took it that the author referred to the joint gate and not the bottom gate. He had been in the habit of seeing that the in-gate on the joint should be smaller. With the bottom gates, he certainly thought they should be larger. With regard to flat ramming, he did not agree with Mr. Worcester at all. It all depended on the class of job that was being rammed.

Mr. Worcester said that he could make a job much sounder with a flat rammer than with the peg rammer.

National Certificates for Foundrymen.

Mr. H. Bunting (Derby) said his opinion was that a man who could ram a job up correctly could make any job. If the job were rammed correctly it was three-parts made. With regard to the use of the needle wire, he thought if it were scrapped in the foundry entirely they would have less trouble. He had seen more scrap castings made as a result of using the needle wire than anything else. He did not altogether diagree with vents if they were made intelligently, but if not, then trouble would result. He disagreed with the remark that the Institute had done nothing to make craftsmen. What the Institute had been doing for years was to try to improve the standard of craftsmanship in the foundry. They were even going further with it, and were awarding national certificates, which should be an incentive for the men in the foundry to come forward and get a better knowledge of the industry than they had at the present time.

With regard to the training of apprentices, it had been suggested that they omit chemistry, but he insisted that it was necessary, if the individual was to study metallurgy, and he was fully convinced it was necessary to include a course of inorganic chemistry. In Derby the Branch had an Advisory Committee, and recently they had met the Principal of the College, who had wanted to include English in the syllabus. The Committee objected, and the subject was deleted. The view expressed by the Principal was that he was anxious the boys should be taught how to express themselves. It was necessary the foundry students should have a course of practical mathematics, because it was realised that the youths in the foundry did not appear to have that standard of education that was found in boys employed in other departments. That was probably due to the fact that lads went into the foundry when they could not get anywhere else. He did not think it so necessary they should teach in the technical colleges the practical side of the foundry work. They could receive that instruction in the works. In a college they might have some students from a first-class foundry being taught something of a job they had done ten or more years ago, therefore it would be a waste of time. The theoretical side was the knowledge they wanted. The Institute had done much for the craftsmen of the foundry industry.

Mr. Worcester said that, although the Institute had done much, it had not gone to the extent they would like it to. He paid tribute to such men as Mr. S. H. Russell and others who had passed through the chair. All had done useful work.

Vote of Thanks.

Mr. C. W. Bigg (Derby), in proposing a vote of thanks to Mr. Worcester, asked if the runner point was not bound up by the rate of metal entering the mould. The area of the in-gate must not exceed the rate of pouring. He did not care what they did in the nature of trap gates, as they were going to have trouble if they did not keep the runner up.

Mr. T. A. Spiers (Leicester) seconded, and the vote having been carried with acclamation, Mr. Worcester said he had enjoyed the visit.

Sheffield Foundrymen and the Badge Question.

The following excerpts, taken from the "Sheffield Telegraph," indicate that the conditions existing in the various sections of the Institute of British Foundrymen are not of the same character:—

"Like Schoolgirls."

Opposing a suggestion for the issue of badges to members for use when they are visiting works, and other occasions, Mr. W. T. Kitching, speaking at a meeting of the Sheffield section of the British Institute of Foundrymen last night, said that badges would make them look like "a lot of schoolgirls going to Glossop Road Baths." (Laughter.)

Members of the Institute did not want to advertise themselves to the world, he said. They were members because they realised the value of membership.

Foundry Technicians' Badges.

London.

Sir,—It is admitted that the suggestion that members of the Institute of British Foundrymen should wear badges did not emanate from Sheffield, and the underlying principle has been distorted by the publication of your report. The originators of the idea had two motives only: (1) The wearing at private meetings (not outside) enabled people to get to know one another better; and (2) to preclude gatecrashing at works visits. Sheffield's stationary population makes the former consideration not so essential as in London, which caters for an area 400 square miles.—Yours, etc.,

A Past-President.

A 400-ton Open-hearth Furnace.—To facilitate the melting down of scrapped automobiles, the Ford Motor Company, Detroit, has ordered a 400-ton tilting open-hearth furnace from the Pennsylvania Engineering Works, New Castle, Pa. This is expected to be the largest open-hearth furnace in operation in the United States and will be specially equipped to be charged with crushed automobiles taken off the dismantling line at Fordson.—"Steel."

A National Scheme of Foundry Education.*

By J. G. Pearce, M.Sc., M.I.E.E., and F. K. Neath, B.Sc.

For a good many years past attention has been drawn to the relatively backward position of the foundry in the general scheme of engineering production, and while many Papers have been published deploring this state of affairs, very little organised effort has been made to improve it. The development of the Institute of British Foundrymen was the first step in this direction, and later the formation of the B.C.I.R.A. showed a distinct desire to tackle this problem in detail. A number of the more progressive firms have done a great deal, and it can now be said that this problem is being slowly converted into realities. Very little effort, however, has been made to deal with the important question of personnel, the earlier discussions being interrupted by the war. On the whole, the standard of the personnel of the foundry industry is deplorably low. There are, of course, outstanding men, but they are few if one considers the total number of ironfounders in the country. If the standard of both the executive rank as well as the ordinary workers is so low in the foundry to-day it will be quite impossible for the trade to put into practice the improvements that are now rapidly coming forward. It is therefore the object of the educational movement to prevent the stultifying of the forward movement of the foundry industry owing to lack of suitable personnel to carry on the work in the foundries themselves.

It has been a commonplace among founders for many years that comparatively few boys seek to enter the foundry with a view to learning the trade of moulder or coremaker, and it has been generally considered that the quality of those entering the trade is not as high as is desirable. On the other hand, patternmaking has always attracted suitable numbers of boys of the requisite type, and in this respect offers a marked contrast to the foundry itself. During the past few years many trades which did not formerly have education schemes have formulated such schemes with considerable benefit to themselves. The engineering, electrical engineering, building trades, gas industries and others can be mentioned in this connection. Retail traders, such as grocers, ironmongers, butchers and drapers have followed.

These schemes are based on the principle that boys can be attracted to a trade provided that they have a reasonable assurance that they will be offered opportunities of learning and of making themselves proficient. If, in addition, opportunities in advancement and promotion are offered to that comparatively small but ambitious proportion which is likely to rise to responsible positions in the trade, all the requirements for ensuring the steady flow of capable youths are met. This has been proved in practice many times.

Two Aspects of Foundry Education.

The training of foundrymen has two sides. In the case of the craftsman it is essential that he should by long apprenticeship acquire the necessary manual skill in carrying out the operations of the trade. His capacity for intelligent work is vastly increased if he also understands something of the scientific basis underlying the operations of the trade. In the case of the craftsman this scientific knowledge does not need to be extensive or mathematical in character. It is, in fact, qualitative rather than quantitative. In the case of the young man who is or who will be a foreman, foundry manager, or foundry cost clerk, or who is engaged in some branch of the inspection or testing of castings, the technical knowledge required is deeper, and the course of training must be arranged accordingly. It is evident, therefore, that the training of both these types of young men must have two parts, one of which can be carried out only in the foundry and the other which can only be carried out in a technical school. Co-operation between the industry and the education authorities is therefore essential to the aim in view.

Many technical schools in the past have endeavoured to run classes for foundrymen or to run classes for those engineering students and others who desire some knowledge of founding, but without the full measure of success which they deserve. The reason for this has been inadequate support from the industry itself and the difficulties arising from uncertainty in knowing what the industry really required its apprentices to know. It is hoped that the scheme indicated below will get over all these difficulties, and that it will provide for a full measure of co-operation between the technical schools in every foundry area and the foundries themselves.

Craft Certificate.

The whole question of foundry education has been discussed for some time past by the Institute of British Foundrymen and by the British Cast Iron Research Association, each of which has an Education Committee. For all practical purposes these committees have been functioning together. After considerable discussion and consideration, and after eliciting the opinions of foundrymen throughout the country through a questionnaire issued by the Institute of British Foundrymen, it was decided that two certificates were required, the first a Craft Certificate intended primarily for apprentices who look forward to being skilled workmen, based on evening school courses starting at the age of 16 for a period of three years for two or three evenings per week.

After discussion with the Board of Education it was finally decided that the examining party should be the City and Guilds of London Institute, which has for many years conducted the examinations in practical subjects and which has very close relations with every technical school throughout the country. The syllabus will cover the subjects of foundry calculations and drawing and foundry technology, and this is now being prepared by an Advisory Committee set up by the Institute of British Foundrymen, on which various educational bodies and the British Cast Iron Research Association are represented. The chairman of this committee is, in fact, Mr. E. R. Briggs, of Rugby, who is also chairman of the Association's Education Committee.

The Craft Certificate Scheme is supported by the Board of Education, and is the official scheme for the whole country sponsored by the Institute of British Foundrymen. Such a certificate is bound to have considerable value in the eyes of apprentices since it will not have any limited or local consequence. For the time being, it is not proposed to hold practical or trade tests in conjunction with this certificate, but both the courses in the technical schools and the examination itself will be descriptive and practical and not technical or mathematical, and the constant use of foundry illustrations familiar to apprentices will make the course of interest to every student.

It should be particularly noticed that the examiner will be nominated by the Advisory Committee, which is essentially a committee of foundrymen, so that the scheme may be said to be one in which the industry has ultimate decision as to what is taught and how the examination papers are arranged.

The National Certificate.

There is a decided demand for a technical certificate of a national character for young foundrymen seeking a qualification suited for those who will have responsible positions in foundries as foremen, managers, cost clerks, metallurgists, inspectors and testers, etc. It is essential that such a qualification be based on part-time instruction in technical schools, and after careful consideration it was felt that a National Certificate Scheme should be formulated which should provide for an ordinary certificate at the end of three years' study, beginning at the minimum age of 16, based on three evenings per week, followed by a Higher Certificate obtainable after a further two years' study, also of three evenings per week. It is intended that the Higher Certificate shall provide the highest type of specialised study in the trade and be of what might be called a university rank. Such a course would demand a preliminary two years' course for elementary school boys. Secondary school or junior technical school boys would be able to begin at 16 on the ordinary certificate course, and School Certificate, Higher School Certificate, Matriculated and Intermediate students could begin at a still further point in the course.

After considerable deliberation it was decided that the required course in founding was allied in a very marked way to mechanical engineering, although there is a number of differences from the ordinary engineering course, particularly in respect of the very great importance of chemistry and metallurgy. It was felt, however, that the problems which faced the foundry executive to-day are primarily engineering problems, problems of price and delivery, and that the purely metallurgical and chemical problems are secondary. These problems may be, and often are, left to chemists and metallurgists who may receive a formal training in chemistry or metallurgy elsewhere, such as National Certificates and the examinations of the Institute of Chemistry. National Certificates in founding are not intended for the training of chemists, even foundry chemists, although they may be of great value to chemists who are employed in foundry work.

In seeking for a duly accredited examining body and after discussion with the Board of Education, it was decided to approach the Institution of Mechanical Engineers, which already conducts highly successful national examinations in mechanical engineering at many technical schools throughout the country. This scheme had the warm approval of the Board of Education, and the Institution of Mechanical Engineers has now established a National Certificate and a Higher Certificate on the lines indicated, sponsored by the Institution and by the Board of Education. The certificates will also be endorsed by the Institute of British Foundrymen in the name of the president for the time being. The first-year course is likely to consist of engineering sketching and drawing, practical mathematics and engineering science. In the second year the same subjects will be continued with a course in inorganic chemistry. In the third year specialisation in foundry work begins with a course in foundry chemistry and metallurgy. In the Higher Certificate course it is probable that of the three subjects studied during the two years, foundry metallurgy and foundry technology will be two.

Provision of Classes.

Some technical schools have already begun classes for these certificates, and in any foundry area it is hoped that employers or employees will ask the local education authorities for such provision to be made, and in view of the formal establishment of the scheme and the interest of the Board of Education, there is every reason to believe that with a sufficient number of students desiring to take the course such a course would be established.

(*Concluded on page* 344.)

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Casting Problems.

INTENSIVE STUDY OF SAND AND COMPOSITION INDICATED.

Following the presidential address, submitted by Mr. Sayers to the West Riding of Yorkshire Section of the Institute of British Foundrymen, the meeting proceeded to a general and informal discussion on foundry problems which have been under the observation of members.

A Drawn Casting.

The President, in opening this discussion, said a problem he had in mind was one set up by liquid contraction or mould expansion—the matter was not clear as to which was the cause of the trouble; authorities differed. For instance, at a Birmingham branch meeting in 1923, the late Mr. R. Buchanan, summarising the state of knowledge on this subject, stated that liquid iron was of greater specific gravity than hot solid iron, else how could the latter float in it? On the other hand, Mr. J. Longden, before the Lancashire branch in 1925, claimed that there was a shrinkage of 4.5 per cent. in ordinary grey iron in cooling to solid. Professor Campion, addressing the West Yorkshire branch at Leeds last session, also gave the impression that the composition of the iron made little or no difference. Mr. Smalley, in his classic researches into this question, found that with certain quick-setting compositions he got no liquid shrinkage at all. But whichever of these differing authorities one felt inclined to support, they constantly found in castings of heavy section a need to introduce more iron into the mould, and the harder the iron the more difficult it was to feed the job sound.

Mr. Sayers drew on the blackboard a rough sketch, shown in Fig. 1, of a casting which was required to be as hard as could be machined. The use of chills in the interior was forbidden for fear of sticking or chilling. Not more than 2 in. of head could be allowed at either end, and, of course, the conical hole was required to bore out cleanly and be sound. The job was made from boards and dried; run slowly from the top, as shown, and fed through a 3½-in. riser until the rod was forced out by the metal setting under it. When stripped, a drawn hole appeared. On seeing the result the customer was mildly sarcastic. Though a mere child in such matters, he thought there should have been no difficulty in producing a sound casting; that the thing had obviously been made wrong way up, and so on. Duly chastened, the job was tried again, casting the other way up, and adding a lump of metal on the bottom as an aid to solidification. In appearance the casting was sound, but on boring out the hole a void was again discovered near the end. No time was available for further experiments, so this casting was bored out as indicated and another casting made, of substantially the shape of the bored-out portion, turned and driven in. They met the conditions of the case admirably, but left still unsolved the problem of casting the original production sound, and he (Mr. Sayers) would be glad if any member could offer any solution to the problem.

Suggested Remedies.

Mr. Thornton: How did you run the job when you inversed it?

Mr. Sayers: The same way, from the top. The iron was about 1 per cent. Si. It was of deplorable iron, the phosphorus content being about 0.8 per cent.

Mr. Thornton: I would suggest the phosphorus was too high. (Mr. Sayers: I agree.) The analysis of 1.6 per cent. of manganese was perhaps hardly satisfactory.

Mr. S. W. Wise (Bradford) said he believed this matter was one of the examples that Ronceray declared Léonard found in his researches on porosity. The whole of the gases generated did not escape, and were occluded in the casting in the shaft through solidification. That was what Ronceray called the Léonard effect. In answer to a further question by Mr. Thornton, Mr. Sayers said the runners were two ¾-in. round runners, and the casting weighed about 8 cwts.

In reply to Mr. W. H. Poole (Keighley), Mr. Sayers said there was strong objection to having denseners in the hole.

Mr. A. S. Worcester (Huddersfield) remarked that it was common, in the case of a small core, to cut across a hole at the top of a set like that, though he agreed it was far better without it.

Mr. Poole said the question of gas effect could be eliminated by putting in 20 per cent. of non-bonded sand in the mixture. This was a steel practice which he (Mr. Poole) felt grey-iron workers ought to use more often. The use of it

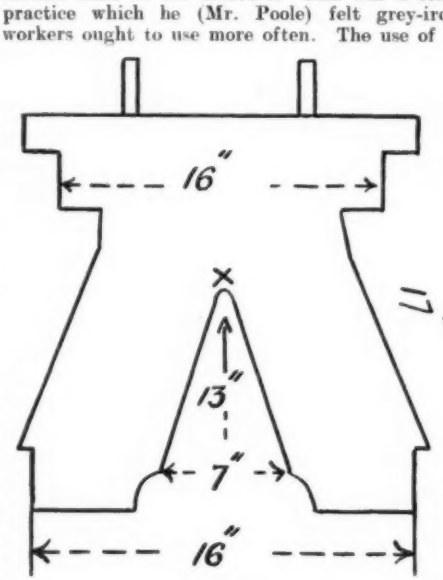

Fig. 1.

for cores where one had a totally-encased core was much better than the ordinary sea sand.

Core Sand at Fault.

Mr. Worcester thought the open core sand would not apply to a lump such as that one. To his mind, they must have a bond in it. The only bond he would use was clay—(Mr. Poole: I agree)—but that did away with the permeability. He found this sort of thing occurring in oil sands, and believed the heat was engendered in the oil.

Mr. Poole: Use an open sand and cut the manure out?

Mr. Worcester: The manure is too combustible.

Mr. Poole said he would certainly use a chill immediately under the top flange. He wondered whether, in the case brought to notice by the President, it might not be preferable to use the Ronceray method as a whole and cut out the feeder entirely.

The President said the idea of the Ronceray principle was that the metal should set as it rose. He (Mr. Sayers) had not complete faith in that method.

Mr. Thornton: The particular runners in this case were too big for the Ronceray method.

Feeding Not Always Useful.

Mr. Poole said the matter seemed to him to raise the whole question of feeding or not. In his opinion, nine times out of ten feeding was a hopeless proposition.

The President remarked that the length of time a job fed depended a good deal on the amount of hot metal in the feeder.

The Secretary (Mr. Wise): It is a very moot question as to whether feeding is as effective as it is commonly supposed to be.

The President said he regarded feeding as an evil, but there were times when it was necessary.

Mr. L. Farrar (Shipley) said, to his mind, the solution of this problem was largely that the riser should be practically part of the casting. That eliminated a lot of unnecessary feeding. It was a cone riser, and the casting was safer with that type of riser than with feeding.

Mr. H. Forrest said it seemed to him that with that type of riser one would have the colder metal in the riser.

Mr. Poole said one of the difficulties in a foundry, in putting on a feed, was to keep the bulk of the metal away from the portion that was being fed. Steel practice was good practice to follow, even for grey iron. The average idea of putting a feed on a casting was hopelessly inadequate.

Mr. Hions (Brighouse) said he was rather inclined to think the porosity was owing to trapped gases. When the thing was turned upside down there would be porosity in the same place. Obviously it could only be caused either by the hot spot or by wrong composition of metal. On the matter of feeding, if one fed from the top, as was illustrated by Mr. Sayers (Fig. 1), and that was not satisfactory, surely if one turned it upside down one had extra head pressure, and there should not be any extra porosity.

The President: There should not be, but there was! Mr. Sayers agreed that the great trouble was in the ways mentioned by Mr. Hions.

Mr. Poole thought possibly a remedy for Mr. Sayers' problem would be to turn the casting upside down, slow run it from the bottom, putting the conical feeder at the top.

An Important Experiment.

Mr. A. S. Worcester (Huddersfield), in response to the meeting's request for other problems experienced by members, recalled that at a meeting at Bingley last session there was some discussion on the question of runners, but it had to be deferred. The question in dispute, if he remembered aright, was that the usual practice was to put top runner in the top and small runners in the bottom. He (Mr. Worcester) contended that that was wrong. One could not skim the metal unless the gate was full. He had tested the matter out. He took the last shank of metal, never skimmed it, went to the runner and poured in, and he had a man holding parting sand poured in at the same time, and the casting was clear.

The Secretary (Mr. Wise): It is a funny thing; when you try to make a waster you cannot.

Mr. Worcester: The less one has in proportion between in-gate and down-gate the quicker one has the skimming gate full.

Mr. J. Butterworth (Halifax) thought the dirt would get up the dirt-riser. When one was pouring metal into a mould, if there was any dirt it was the first drop that entered. He thought the top gate should be on the top joint and one should have the half riser over the top of the riser.

The Secretary: It has to be choked first.

The President: It is a question of length. The further the iron runs the cleaner it will become.

Mr. Worcester: You must have a length of skimming surface on the runner. The longer that is the better.

Aluminium as Remedy.

Mr. Poole, on behalf of Mr. Moffatt, illustrated on the blackboard a pipe cast horizontally.

(*Concluded on page* 344.)

Some Features of the Pulverised-Coal-Fired Air Furnace.

By E. F. Wilson.

(*Concluded from page* 322.)

Features affecting Oxidation.

The problem of oxidation within the air furnace is not essentially one of amount but rather of regularity, in order to duplicate the rate from heat to heat. However, undue oxidation results in higher refractory consumption and metal loss, greater labour in slag removal and the use of silicon and manganese as a fuel where cheaper agents could be used.

Mechanics of Oxidation.—The mechanism of oxidation is, briefly, the attempted development of an equilibrium between the oxygen in the gas phase over the metal and the slag consisting of ferrous and ferric oxides, with those of silicon and manganese; and these, in turn, with the molten iron. Carbon and silicon oxidise with reduction of ferric to ferrous oxide, which is reoxidised to its original condition by the gas stream. The nature of these reactions has been studied by others.[3] The part of the charge nearest the burners is prone to the greatest oxidation, and flattening the metal to the greatest extent serves to equalise both the heat distribution and the gases rich in oxygen. Thus the concentration at any time is kept at a point where scaling will not exceed an undue amount.

The metal containing the more combined carbon oxidises the most freely, as well as that offering the greater surface for exposure. All these factors should be kept in mind should conditions require a change in melting practice or melting stock. If a portion of the stock is heaped to one part of the furnace so that its mass delays the melting, considerable scaling will ensue. The furnaceman, by vigorous application of the bar, can dislodge the material and so hasten the fusion process. Facilities for furnace charging are not always of the best, so that inequalities in heaping the stock are quite likely to occur. Proper working then is necessary to offset such irregularities.

Carbon Oxidation.

In a study made some time ago, the writer was able to develop that the oxidation of carbon and silicon increases with the original content of these elements respectively. This would be the rational expectation in line with the law of mass action. Manganese and silicon oxidise at rates of quite definite proportion to each other, while carbon and silicon oxidations show no clearly-defined relationship.

Any protective effect of the silicon to the carbon would probably be clouded by the course of the furnace operations. A decrease in carbon oxidation external to changes in the charge often will be accompanied by a sulphur pick-up, which is a condition indicative of coal depositing on the bath and acting as a recarburiser. In a study of oxidation from the first to the last of the week, an average progressive increase was found. However, variations were so frequent and wide that the general tendency could not be used as a safe rule.

Causes of Increased Oxidation. — Further analysis indicated that this feature probably was due to increased opening of bridge wall, due to cutting of the bung and top of bridge. Possibly the presence of oxidised pools of metal in the furnace bottom may have added to this. It is well known that the morning heats with a colder furnace are more prone to oxidation than those of the afternoon when the furnace has not had time to cool. Monday morning heats, which in personal practice are associated with a newly-rebuilt furnace, are abnormal on account of the preliminary drying necessary. The timber used to protect the bottom also acts as a recarburiser to some extent.

Oxidation of Silicon.

The oxidation of silicon occurs early in the melting action, and as the temperature rises the carbon-oxidation rate increases, with a consequent protective effect on the silicon. The same phenomenon is even more clearly revealed in the reactions of a Bessemer converter. A graphical analysis covering a large number of heats showed that the oxidation of silicon decreased with speed of heating up to some point near "melted." From "melted" to "tap" the oxidation rate of silicon decreases and that of carbon develops rapidly.

This characteristic is of practical value—the furnaceman, by knowing whether or not the charge melts at the normal rate, can estimate his silicon oxidation accordingly. If he holds the metal at high temperatures, a high carbon loss may be expected, and he should meet the situation either by reducing the heat input or by adjusting his fuel mixture as to drop coal and recarburise the iron. A charge which requires longer than the usual period to "melted" for the tonnage concerned, may be expected to give a high silicon loss.

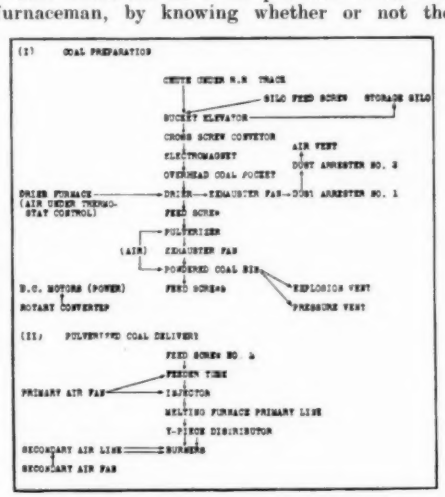

Fig. 4.—Flow Sheet of the Coal-Pulverising System for Air Furnace.

Causes of Increase.—Oxidation increases with increase in driving the furnace or the amount of air for combustion forced through the chamber at any one time. This results in increased melting speed, so that the action is more pronounced in the carbon oxidation than that of the silicon—possibly, too, because of less coal dropped on the bath. On occasions, an abnormally higher silicon content will be obtained, and this can be related to a strongly-reducing atmosphere at high temperatures, wherein the silicon is reduced from the slag. This feature is also common to acid open-hearth practice.

Sulphur.—In the use of fused soda ash for the reduction in sulphur, a decrease in the metal content of silicon and manganese should be expected. The amounts may depend on the application of the desulphuriser and need not necessarily be serious. The alkaline character of the flux runs true to usual reactivity.

Controlling Oxidation.

Oxidation during pouring of the heat frequently is a source of trouble, due to the high temperatures obtained in the furnace at this period. By proper manipulation this can be controlled, however. The writer has a series of analyses from 15 heats, both of the morning and afternoon and taken at weekly intervals, which show the following average oxidations from the first to the last of the pour: C 0.027, Si 0.015 and Mn 0.007 per cent. Skimming the slag may be carried out as soon as part of the iron is molten, in order to speed the heating effect by eliminating the slag blanket. However, if it is desired to restrain oxidation, the slag may be left on to advantage; in fact many foundries do this, skimming only just before they are ready to tap.

Slag Removal.—The mechanism of skimming is entirely by hand and the working conditions are quite severe. A long bar with a steel strip on the end is supported and balanced on a hook suspended from above. The bar is inserted in a working door at the rear of the bath, and the slag which floats to this end under the impetus of the draft is readily skimmed and pulled out of the slag door. This drops into a slag tub, is cooled by a spray of water and is removed to cool.

Slag removed at too low a temperature is inclined to hold suspended metal. This can be reclaimed to some extent by breaking up the cold slag with a sledge and removing the larger pieces of iron. Magnetic separators are not universally employed, as good practice cuts the recoverable metallics to a negligible figure, especially where the total slag amount is small.

Slag Characteristics. — Normally the slag volume should be indicative of the amount of silicon oxidation, as indeed has been shown by certain data. However, this is influenced by such matters as temperature, condition of the furnace bottom and firebrick, as well as melting speed and scale and sand on the entering charge. It is believed that this explains the erratic nature of results obtained from such studies as the writer has made. The appearance of the slag formed may be from light and spongy to a vitreous, dense material, to a stony or tough and dense character. The colour may vary from a brilliant black to various intermediate shades of brown. This gives some idea of the variety of this product.

Table I.—*Characteristic Analyses of Air-Furnace Slag.*

	FeO.	MnO.	SiO_2.	S.	Al_2O_3.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
First skim :					
1st tub ..	35.45	2.99	45.44	0.069	14.65
5th tub ..	29.88	2.04	49.20	0.054	17.44
Second skim :					
1st tub ..	30.44	2.81	49.36	0.035	16.57

Analyses of Air-Furnace Slag.

Characteristic analyses of the air-furnace slag may be found in Table I. Iron oxides in these exist as FeO and Fe_2O_3, in which the former greatly predominates. For this reason the oxides of the group were all calculated as of the ferrous form. The decreased oxidation of iron and manganese at the last of the first skim, and its slight increase on the second, are noticeable, as well as the progressive decrease of sulphur, which is probably a straight function of ash deposit from the coal. A preliminary investigation points to the connection of atmospheric temperature to oxidation within the air furnace. As a more extended study is now under way, no report will be made at this time other than this mention.

Furnace Operations.

As stated elsewhere, the charging and distribution of stock plays an important part in subsequent melting. It is the writer's practice to

place the steel and hard-iron sprue in the foremost part of the furnace and the greater part of the pig-iron in the rear. This locates the more difficult melting metal at the zone of initial higher temperatures. The pig-iron is placed by a peel, while the sprue and malleable scrap is handled in steel pans. The steel rails are handled individually. The charge openings are the side doors at the rear and two places at the front made by removal of the bungs.

Method of Charging.—The charge is brought to the furnace on skid platforms by electric trucks and raised to proper height by the truck elevator. To charge through the roof, the workmen use a transferable steel platform and stairs. Unfortunately, entirely mechanical charging is not yet feasible. The furnace is lighted by inserting some oily waste or bags through the light hole in front of the burners. The primary or coal-conveying air is next applied. As soon as the coal flames, which is almost immediately, the secondary air is gradually applied and furnishes that required to complete the combustion. The stack smoke whitens very shortly and then becomes nearly nil.

Absorption of Carbon.—The charge containing the highest combined carbon has the lowest melting point, which is the pig. The hard-iron sprue has the next lowest, and finally the steel. Free carbon is taken into solution into the metal as the temperature rises, but some remains, it is believed, even after the iron is molten. The pig-iron sweats and usually is well advanced before the other components of the charge melt appreciably. In this consideration is the effect of stock mass, which lowers the hearth temperatures accordingly.

To equalise the melting process, the furnaceman bars down the stock by thrusting the solid material into the molten pools for solution, generally flattening the charge as much as possible. By the use of green poles he may boil the fused metal on to that which is still frozen and dissolve it in this fashion. Poling also has the effect of mixing the iron and raising the cold layer from the bottom, where it normally remains due to its higher density. As soon as the greater part of the bath is molten, the first skim follows to assist the heat transfer from the flame. All this description signifies but one practice; others differ as circumstances dictate.

Air Control.—As the primary air mixture is relatively constant, any variations to be made in the total air are through the secondary supply. After considerable experimentation with various coal and air mixtures, it was concluded that full air from the start gives us the best melting economy in a metal to coal ratio, as well as giving the greatest speed. The air can be cut somewhat in later stages to give a less oxidising condition. To maintain a slight pressure within the furnace, the draft can be regulated by adjusting the stack and flue doors. The operation of these is guided by pressure or suction at peepholes in the working doors along the side of the furnace.

Determination of Heat Progress.

As the heat advances, methods must be taken to learn this progress in order to tap at the proper interval and to make any corrections necessary. Even with the highest skill and care, modifications outside the operator's influence produce small to large variations which must be expected and provisions made for their regulation.

Cup Test.—Temperature tests ordinarily are made by the test-ladle method. A small amount of metal is scooped from the bath in a cup ladle, the whole placed within a hood as to be protected from drafts of air, and the number of seconds counted until the metal surface commences to cloud. The time interval at which the ladle completely clouds over may be used also.

While the temperature is a function of the rejection from the metal of this cloud or slag, the writer believes that various other factors also play an important part. These may be enumerated as follow: (1) Freshness, character and thermal conductivity of the fireclay on the ladle; (2) carbon content of the metal; (3) representativeness of sample, and (4) atmospheric temperature or humidity.

Fluidity Test.—Another test characteristic of temperature is the fluidity test. This is measured by a device suggested by C. Curry,[8] consisting of a spiral casting with spaced buttons. The extent to which the iron flows, in pouring this, is indicative of the fluidity and—at constant analysis—of the temperature of the metal.

Steel-Rod Test.—Steel-rod tests have been suggested to determine the temperature of the iron as poured into ladles. Inserting a $\frac{3}{8}$-in. rod into cold iron leaves a somewhat pointed end, while hot iron melts off the end, leaving it short and feathered. If the rod is inserted in somewhat cool iron to the bottom of the ladle, the maximum attack will be indicated at the middle of the mass and tapering off to both bottom and top. The writer's organisation has not been very successful with the rod tests due to difficulty of setting standards of measurement and duplication. Furthermore, such tests measure the iron after tapping, after which no further heating can be accomplished.

Optical Pyrometer Control.

The use of the optical pyrometer, while decidedly more scientific than the other devices, also has the limitation that it cannot be used readily to determine the temperature of the melt within the furnace without special adaptation. It can be used by sighting on the metal issuing from the tap hole, but even this is subject to errors due to dust and smoke, which seem natural accompaniments of most foundries.

Repeated attempts to correlate apparent temperatures—as determined by the aforementioned methods—with other results have not been totally successful in the writer's experience. A method of temperature determination and recording applied to the cupola, in which a hooded thermocouple is placed over the pouring spout, has been reported by H. W. Dietert.[9] A similar installation might be applicable to the air furnace, but no such instance is known.

Test for Degree of Graphitisation.

Since primary graphitisation is to be avoided in the malleable foundry, some operators are accustomed to pour test pigs and permit these to cool in sand, then noting any tendency to graphite separation. The pigs preferably should be poured in covered moulds and may be about $3\frac{1}{4}$ in. by $3\frac{1}{4}$ in. in section and about 12 in. long, minus draft. They should be notched in the middle to aid and localise fracture. Pigs should be poured at different parts of the heat in order to include the effect of temperature or other variation upon graphitisation. Any such graphitising tendency should call for tests to be made of any other castings which are of large section.

To gauge the approximate oxidation of carbon during the melt, test sprues are taken when the iron is first melted, and at intervals following until the heat is ready. In personal practice, these testers are 7 in. long and tapered slightly from 2 in. in dia. Smaller pieces would have the advantage of cooling more readily and hence being more quickly available, but as the tendency to graphitise is not so great, they would be less informative.

Best Results from First Tester.

As a rule, it has been found that the first tester taken is the most indicative of the condition of the metal. The testers are poured in sand and allowed to remain there a definite period, then are quenched in water. They are then broken and the fracture examined for graphite spots. The number and size of these are significant and may call for doping or additions to the metal if the appearance is abnormal and verified by subsequent testers.

Variation in height or location of fracture, even within $\frac{1}{2}$ in., affects the apparent reading of the tester. To avoid this, the test sprues may desirably be notched by so constructing the pattern and splitting it. If a melting programme is properly adhered to, oxidation and the resulting analysis of the melt may be duplicated with relatively small variation. Unfortunately, this may be subordinated to other features such as inadequacy of moulds made to accommodate the tonnage at regular tapping time. Also, a certain degree of skill is necessary to make adjustments if any part of the melting procedure is markedly out of line with the time schedule.

Final Analysis.—The metal for final analysis, or that taken as representative of the heat, should be from the middle of the pour. The test sample may consist of a small block convenient for drilling. This should be free from shrinkage or other segregation. In malleable foundry practice the block consists of hard or white iron. One of the biggest problems connected with air-furnace practice is the difficulty of temperature determination of the metal. It is felt that investigations in this direction would be an excellent field for specific research and that great service to the industry would result from organised sponsorship of such studies.

Doping the Melt.

Whenever the metal is out of bounds in respect to analysis at the tapping period, doping may be resorted to in the direction of and amount as indicated by the heat-test sprues from previous experience. To recarburise the metal, petroleum coke may be used to advantage by adding the required quantity in paper packages. Other forms of carbon may also be used. Silicon and manganese additions are usually made as ferro-silicon and ferro-manganese. The proper lump size of these alloys allows of quick solution without too great flotation and oxidation.

Green poles may be used to boil the metal and dissolve the lumps more readily. About twenty minutes is generally conceded as the minimum desirable for solution and mixing. Whenever ferro-silicon is used, ferro-manganese should be added likewise, as the oxidation of the two go together.

Use of Steel Additions.—To decrease the content of the metal in elements other than iron, steel additions may be made. The effect is one of diluting, and the chilling of the bath may result in oxidation of the silicon at the expense of the carbon. Mill scale may also be employed for the same purpose. It is endothermic in action and may result in changes in reaction rates, with the preferential oxidation of carbon or silicon depending on whether or not a critical temperature is exceeded. Recarburisation may be accomplished by dropping coal on the bath, but not to a readily controllable extent. Whenever coal is so precipitated, sulphur pick-up may be expected and, in fact, any sudden increase in sulphur content usually indicates this action. If some doubt exists as to the required amount of doping, such as in silicon additions, these may be made in a cup ladle and the metal poured. The information derived from the tester obtained may be construed for larger quantities.

Pouring the Melt.

Tapping the furnace is accomplished by clearing out the sand from the tap hole, then breaking through the final section. Care must be taken not to disturb the breast during this operation. If the iron freezes as to plug the tap hole, the tapping rod may be heated on the end in the bath and thrust through the solid film.

Boiling the metal against the tap hole by green poles may be effective also. As a last resort, oxygen may be used to burn through the hole, care being taken not to enlarge it too greatly. To heat up the hand ladles, the first of the metal may be caught with these and returned through the pour-back. Bull ladles then follow and

supply metal to parts of the foundry remote from the furnace.

Pouring on Both Sides.—Pouring can take place on both sides. The bull ladles in the author's practice hold from 350 to 400 lbs. The hand ladles hold up to 80 lbs. The speed of pouring with the accommodation available averages three minutes a ton and approaches two minutes with a continuous pour. Values for oxidation during pouring have been given elsewhere, but candour requires the admission that this is excellent practice and may not be obtained at all times. A drop in 20 points of carbon or more can easily occur from the middle to last of the pour. To prevent this, the coal and air are decreased and back pressure created by opening the stack and flue doors. Silicon reduction is liable to occur at this period.

Features of Combustion.

The generally accepted concept of the transfer of heat to the metal in the air furnace is mainly through convection at lower temperatures and through radiation at higher temperatures. Since the radiation is a function of the difference of temperatures of the fourth power, its effectiveness grows rapidly with increase in flame temperatures.

Flame Temperature.—The furnace roof provides a reflecting and radiating medium, especially when glazed by fused ash on the exposed surfaces. The flame itself has similar ability and the triatomic gases have high radiant properties and the diatomic less so. Investigators have pointed out the criticism, however, that CO_2 and H_2O are final products of combustion and are chiefly beyond the flame proper.[6] This would also infer the best heat transfer with a short intense flame.

The gaseous flow within the furnace is similar to inverted hydraulic passage, according to the investigations of Groume-Grjimailo.[7] The simile is made more complex by the difference in density of gases of widely different temperatures. The effect of the rear bridge in the air furnace is comparable to an inverted weir. Further discussion would only treat inadequately of the matter in a report of this sort.

Adjustment of Burner Nozzles.—Burner-nozzle adjustment laterally should be such that if double burners are used the streams should converge at a point where no interference with flaming or ignition will result. An unbalanced condition may be reflected in excess sidewall brick consumption if some part receives more heat and abrasion than the opposed. The sloping of the burners in a vertical plane should meet the condition wherein the increased temperature of gases and resulting less density causes their lift before striking the bath. As the energy of propulsion from the burners is expended in passage, the gases are sucked from the furnace chamber by the draft created in the stack.

Arriving empirically at the proper burner adjustment, the proper distribution across the chamber section may be checked by a suitable device. For this purpose a wood strip may be used, with small flags suspended at short intervals along its length. By holding this at various points, the amount of flutter across the strip indicates the gas flow in operation. This cannot take into consideration, of course, any changes due to temperatures.

Bridge Wall Openings.—As a result of extended experiments, but slight effects of change in the furnace design were found. No material changes from the bridge wall opening were considered advisable. With the construction described, a bridge wall opening height of 7 in. at each side and 13 in. at the centre was found optimum for metal-to-coal ratio and accompanying melting speed. This gave an area of opening of about 692 sq. in. Less than this amount gave somewhat better fuel economy but slowed the melting speed too greatly. A larger opening permitted of greater speed but with high fuel consumption.

The inverse relationship is characteristic. In order to maintain this opening fairly constant, it was found necessary to build up the rear bridge wall at intervals throughout the week. Melting speeds and metal-to-coal ratios are affected by the tonnage, both rate and ratio increasing on larger melts up to the rated maximum capacity of the furnace. With proper design, this will be the optimum and greater tonnage will give no advantage. The maximum rate of speed with the furnace shown in the accompanying sketches has been developed at 15 tons, although 17 tons have been accommodated at times.

Fuel Economy.

Fuel economy usually is expressed in terms of pounds of iron melted to coal consumed. Such values may be taken up to the time of tapping or include the coal used during the pouring period. This latter feature is usually external to melting efficiency, but is interesting from a point of view of over-all. The average foundryman, when questioned as to his metal-to-coal ratio will quote, in all probability, his best or near best value. This is commendable optimism, but gives no idea of an average ratio covering practical conditions. Since such values depend on size of furnace, melting stock, combustion equipment, melting speed, fuel and operation—as dictated by other features in production—none will be given here. Comparison is based only on over-all economy.

Powdered-Coal Combustion.

According to current appreciation of the mechanism of combustion of powdered coal, this action is divided into several stages. These stages do not necessarily occur in series of definitely defined steps, but may overlap to a great extent. The order may be expressed in the following arrangement:—

Endothermic Reactions.—(1) Drying to remove moisture and (2) heating to drive off volatile matter.

Exothermic Reactions.—(1) Combustion of the volatile gases; (2) primary, additive oxidation of the coke (non-volatile matter of the coal), and (3) oxidation of the coke at such a rate as to constitute ignition.

In order to make the best application of the combustion processes, it is necessary to have a luminous flame of high thermal intensity to create a large temperature difference between it and the stock. The higher the flame temperature, the greater the heat transfer and the shorter the flame length which effectively should extend only across the combustion chamber. To reduce the stack losses to a minimum, a rapid liberation of heat is necessary in the air furnace.

Factors controlling Rate of Thermal Transfer.—The features which concern the rate of thermal transfer are: (1) Per cent. of volatile matter; (2) moisture content of fuel; (3) air proportion in consideration of attendant features; (4) degree of turbulence; (5) temperature of combustion air, and (6) degree of pulverisation.

Volatile Matter.—The volatile matter of the coal determines its approach to gasification with rapid oxidation of the hydro-carbons evolved. Their combustion also aids that of the non-volatile fuel.

Moisture Content.—Moisture content of the coal is more important in a straight-line, short-travel chamber like the air furnace than in other heating furnaces where the heat transfer may be more readily extended. However, no difficulties may be expected in keeping the moisture under a required value with average practice.

Air.—The amount of air for combustion concerns both the degree of cooling of the flame on entrance to the reaction chamber and the amount of sensible heat removed in the waste gases. To supply a unit of oxygen requires four additional units of other gases, which play no part other than to dilute the reacting constituents and act as thermal carriers to the stack. Less than the theoretical quantity of air to complete the combustion implies a loss through unconsumed fuel.

As a strictly theoretical amount of air may not always assure of combustion completed within the proper interval, in practical operations an excess of air is sometimes advisable. Obviously this should be maintained at a minimum for best over-all efficiency. Due to the diluting effect of inert gases and the interfering envelope of combustion products surrounding the coal particle, oxygen present does not always infer oxygen available. For this reason a slight excess may be necessary.

Degree of Turbulence.—In ordinary grate firing, the fuel is held stationary and the oxygen passed through the mixture. Intimacy of contact is dependent on surface exposed and volume passing per coal unit. In pulverised-coal combustion, the problem is complicated by the conveyance of the coal at velocities near that of the air—velocities implying both direction and rate. To acquire continued contact with fresh oxygen and removal of oxidised or inert gases, relative motion is necessary either by difference in speed or cross flow.

The slowness of travel of coal particles is limited by the point at which they cease to be suspended. This is dependent on fineness of the fuel, static pressure of the medium air and its velocity. The factor of turbulence adds to the total path of the coal before emptying into the flues and increases its liability to total oxidation previous to this. Avoidance of a straight-line flow should be observed as much as possible within the limitations of the furnace design. The cutting down of the bridge wall opening probably adds to the turbulence created by the effect of decreasing the stack induction.

Temperature of Combustion Air.—Preheating of the primary air is not feasible, and such treatment of the secondary air meets with mechanical difficulties. However, the advantages are obvious and well recognised by combustion engineers. A practical solution to this problem would be a distinct technical advance and would add greatly to present efficiencies.

Degree of Fuel Pulverisation.

Degree of pulverisation is the multiple of exposed fuel surface to the available oxygen. It acts in the direction of and supplements turbulence. The limit is defined by grinding economy from an over-all point of view, considering the resultant combustion obtained. Theoretical matters of powdered-coal combustion have been ably reported by Dr. Rosin[8]; in his work he treats of the dual rôle of temperature in affecting the combustion rate, as well as other phenomena.

Fuels.

In air-furnace practice it is agreed generally that highest economy results from the best commercial bituminous coal possible. Acknowledging the possible merits of other coals, the following analysis may serve as a guide for a suitable fuel:—Calorific value, B.T.U., 14,000 minimum; volatile matter, per cent., 35 minimum; ash, per cent., 6 maximum; sulphur, per cent., 1 maximum; moisture, per cent., 3 maximum.

Screen tests of the powdered coal should be made at regular intervals to check on the economic grinding speed for the material involved, or to denote excessive wear of grinding parts. The commonly-stated fineness for efficient furnace operation is 85 per cent. through the 200-mesh screen. Some recent opinions have been to the effect that the coal passing through the 100-mesh is more important, since this represents a sort of critical fineness beyond which no difficulty is likely in rapid combustion. The degree of fineness greater than the usual range has only an economic limitation in the extent of pulverisation desirable.

Drying of Coal.

Drying of the raw coal apparently has its main benefit in greater ease of pulverisation. Pow-

dered coal, however, is highly prone to moisture pick-up and—both for purposes of more efficient combustion and to prevent undue packing in storage—should be kept at a low-water content. Under 1.5 per cent. moisture of physical combination will offer no serious difficulties. The drying of the raw coal should generally be around 120 deg. C. Much greater temperatures will result in some distillation of volatile matter, with its attendant danger of ignition.

The fusion point of the ash from the coal is important, and its significance depends on other factors, such as the amount of cooling in the flues. The ash should be sufficiently refractory as to avoid choking the flue or agglomeration affecting its flotation from the stack. While wishing to avoid any discussion of equipment, the accompanying flow sheet (Fig. 4) is included to show a typical arrangement of coal preparation in a central system for pulverised coal. The items are practically self-explanatory.

Bath Reactions.

The chemistry of the melting process within the air furnace must be studied only by analogy at present. No published consideration of the bath reactions is known, and all hypotheses must be based on what we have learned from similar melting procedures. Of these, the acid open-hearth has the nearest relationship and stands in the position of a big brother.

Materials affecting Bath Reactions.—In the treatment of the bath chemistry it is essential to enumerate the interacting substances involved and their sources. These are as follow:—(1) Alumina and silica from the refractories; with these are small amounts of alkalis or other compounds as impurities in the brick; (2) silica from the furnace bottom; (3) iron from the charge, holding carbon, silicon, manganese, sulphur, phosphorus and minor elements; (4) ferrous and ferric oxides, as the magnetic and the free ferric oxide; these appear as usual accompaniments of the charge; (5) silica accompanying the sprue in the charge if this portion has not been tumbled; (6) silica from the powdered-coal ash; (7) carbon from the fuel; and (8) oxygen, carbon monoxide, the dioxide, nitrogen and water as hearth gases. Of these, the refractories and part of the stock before melting all of the charge exist as a solid phase, the slag and metal as liquid, and the air and its combustion products as a gaseous phase. All of these, it will be noted, are subject to heterogeneity of components.

Oxygen and Oxides.

Oxygen acts upon the cold charge, converting the iron to scale, usually in the form of Fe_2O_3. As the temperature rises, the oxidation may be expected to advance, as indicated by increasing slag volume. The ferric oxide in presence of the molten iron probably will be reduced in part to FeO. A portion of this will dissolve in the bath and the rest in the slag, according to differential solubilities in these adjacent solutions. The extent of the decomposition of the ferric oxide will depend on the approachable equilibrium at any specific moment.

This will be modified by temperature, chemical nature of bath and the slag, diffusion rate—particularly in relation to the reaction velocities—and inhibiting features relating to the mechanics of the transfer. A complete formulation of these affecting matters is limited by our ignorance and their probable multiplicity.

Effect of FeO.

FeO may be expected to combine either with carbon or silicon and manganese, depending on the bath temperature and mass effect, *i.e.*, the relative proportions of these elements. The extent of the reaction is dependent on the oxide solubility, which is increased by additional temperature and decreased by carbon and silicon content. This feature is pertinent in practical operations. One may consider a system starting with a gaseous phase of oxidising oxygen, carbon dioxide and moisture or its dissociated products. This at any instant is striving to acquire equilibrium with the slag and assumedly in the direction of increasing Fe_2O_3 in respect to FeO. The slag is decreased in free FeO by combination with silica from the ash, refractories and other sources. It is also impoverished by continued partition to the bath. In the bath itself, FeO is acted upon by carbon or silicon, depending on circumstances, previously related.

Silica.

Silica formed, it enters and helps to change the character of the slag, while the carbon monoxide evolves to burn to the dioxide, this evolution being repressed by the viscosity of the slag blanket. In view of reaction tendencies it must be retained in mind that they are affected by the least mobility of any dependent reaction throughout the series. It has been shown that the effect of temperature where, under favourable conditions, reversal of the ordinary actions occur and silicon may be reduced from the slag to the bath. Velocities of reaction are variable as well as rates.

When the slag is skimmed, one has for an instant the hearth gases in contact with the molten metal; then an oxide film tends to form. This may be considered as a type of slag of different physical properties than that hitherto considered, in which the ferrous oxide having less available silica present is more reactive to the carbon of the bath. Slags first formed are subject to heavy silica and oxide additions from the scale present. These would then have the slowest approach to equilibrium with components present. No consideration has been made of the temperature gradient from the top to bottom or to different parts of the bath, but undoubtedly there is this effect. In likening the air furnace to an open hearth, it must be remembered that in the latter the metal volume is small in proportion to the side-wall and bottom contact and probable attack.

Modifications of the Air Furnace

An installation by using the cupola in conjunction with the air furnace in a duplexing operation has been reported. Unfortunately, the writer has not the reference available for description. In Germany the Wüst furnace has been developed, and one of a single-ton capacity used in the foundry of the Maschinenfabrik Esslingen.[9] The relationship of this to the air furnace exists in the use of an oil-fired reverberatory, with a shaft furnace on the end, which empties on to a slope to the bath. The shaft enters into a preheater for the combustion air. The combined values of the cupola and higher temperature furnace are said to be obtained.

Acknowledgment and thanks are due to Mr. R. E. Bryant, Vice-President of the Jefferson Union Company, for assistance and direction in much work from which the information in this Paper is derived. Further acknowledgment is made to Mr. C. H. Stebbins, President of the same organisation, for interest and encouragement prompting specific studies upon which the writer reports.

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Casting Problems.

(*Concluded from page* 340.)

and said the question at issue was of the method of running it and the composition of metal suitable to withstand 100 lbs. pressure.

A brief and very informal discussion ensued on this matter.

The President said there was sometimes a certain type of iron which it was found had oxidised in the blast furnace. A remedy for oxidised iron was to put a little aluminium in the ladle.

Defective Corrugated Rollers.

A member asked how would the meeting suggest casting corrugated rollers on a 2½-in. shaft about 5 ft. long and 6 in. dia.? At his foundry they had cast scores satisfactorily and ran them at the top ¾-in. runner; and then, without any apparent change of practice, they would find themselves running three or four which were all dirty along the corrugation.

The President suggested that perhaps the trouble had come from boiling off the steel.

The member: We have cast them hot and cast them cold. We have dressed the shaft with red lead and turpentine, but still have had the trouble.

In answer to Mr. Poole, the member said the shafts were bright, not black.

The President said he did not consider red lead or turpentine did any good, though they did no harm. A bit of engine oil smeared around was better. The member might try painting the shaft with water glass.

The Secretary asked whether the member always used the same steel, and the reply was that the same result had been experienced with steel and with wrought iron.

The President said it rather looked to him as though a certain amount of slag had been made with the metal agitation, and it had stuck to the mould. It might be worth while trying running from the bottom to cast more quietly. If they were only occasional bad ones it rather looked as though the fault was in the shaft.

In response to the invitation from the General Council of the Institute for appointments from the West Yorkshire branch to the National Technical Committee, the meeting nominated Messrs. A. S. Worcester and H. Forrest.

The Secretary (Mr. S. W. Wise) reported completion of arrangements for a visit, on November 1, to the undertaking of Messrs. J. Blakeborough & Sons, Limited, Woodhouse Works, Brighouse, to be followed by light refreshments in the works canteen and an evening lecture, appropriate to the visit, by a member of Messrs. Blakeborough's staff.

A National Scheme of Foundry Education.

(*Concluded from page* 339.)

It is important to note that the yearly examinations for the National Certificate are held at the technical school by the technical school. In the case of the Craft Certificate school examinations are held at the end of the first and second years. At the end of the third year the final examination is taken at the school, but the paper will be set by the examiner appointed by the City and Guilds of London Institute, acting on the recommendation of the Foundry Advisory Committee. It is hoped in a later issue to give representative syllabuses for these courses, and the full co-operation of the industry is earnestly requested in order to make the scheme a success. Development in foundry technology during the last few years has been remarkably rapid, and only by an educational equipment of the kind planned above will a foundry be likely to have a staff capable of following with understanding developments in this and other countries and to apply the results to the advantage of the foundry concerned.

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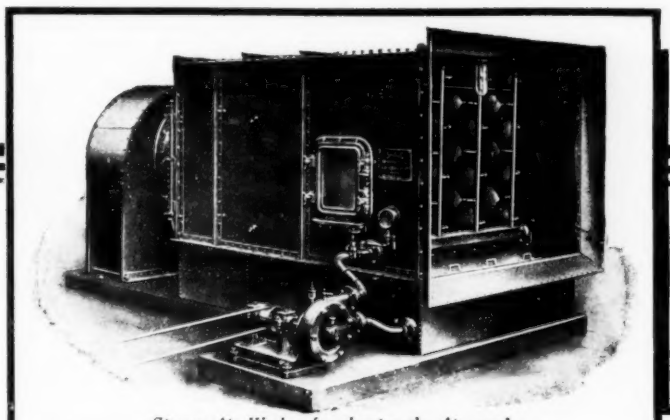

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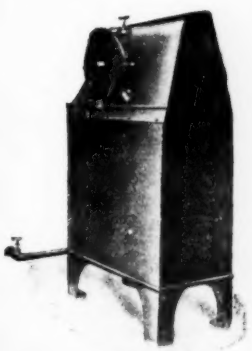

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PLUMBAGO

CORE GUM

WHITE DUST

COAL DUST

REQUISITES

Trade Talk.

A strike was declared in Madrid on Monday by workers in the metal trades, who are demanding an increase of wages. Eight thousand men are idle.

The plant of the Cleveland Dockyard, Middlesbrough, owned by the Parsons Marine Steam Turbine Company, Limited, of Wallsend, is to be sold by auction.

The North British Locomotive Company, Limited, of Springburn, Glasgow, has acquired control of Messrs. Halley Motors, Limited, of Yoker, near Glasgow.

Large deposits of a beryllium ore are reported to have been located near South Gate, California. This ore compares favourably with sample deposits from China and Germany, and the tonnage is apparently unlimited.

Messrs. C. A. Parsons & Company, Limited, of Heaton Works, Newcastle-upon-Tyne, have received an order from the Copenhagen Municipal Lighting Department for the supply of electrical plant amounting to £142,000.

The next luncheon of the London Iron and Steel Exchange will be held at the Great Eastern Hotel, Liverpool Street, on November 18, at 1.15 p.m. Mr. F. W. Harbord will give a short address on "Some Problems of Our Steel Industry."

Messrs. Ruston & Hornsby, Limited, Lincoln, have secured a contract for three sets of six-cylinder oil engines for generating electricity in connection with the Manchester Corporation's waterworks scheme at Haweswater, Westmoreland.

Mr. L. M. Angus-Butterworth, a director of Messrs. Butterworth Bros., Limited, Manchester, gave an address on "Rationalisation" to the Chemical Section of the Manchester Literary and Philosophical Society on Friday, October 31.

Under the profit-sharing scheme of Messrs. Ley's Malleable Casting Company, Limited, of Derby, nearly £10,000 will be divided amongst the firm's employees at Christmas as a result of the profits on the year's working. The bonus will be shared among employees in proportion to the wages earned.

Four additional members of the staff of Messrs. Hall & Pickles, Limited, Manchester and Sheffield, have been presented with watches in recognition of 25 years' continuous service. Apart from the present directors, the long-service roll now numbers 21, in addition to four members of the staff now retired.

The directors of Messrs. John Brown & Company, Limited, intimate that the call to be made on the partly-paid shares on November 29, which was announced at the time of the reorganisation scheme in May last, will be 1s. 3d. per share only, a similar amount becoming due on January 31, March 31 and May 30 next.

It is reported that the Dutch Government have invited tenders for two flotilla leaders and three light cruisers, and Messrs. Yarrow, of Scotstoun, are confident of securing at least a part of the work. The firm have a long and friendly association with the Dutch Government. The new destroyer "Van Ness," the last destroyer of the new flotilla constructed by Rotterdam builders to the designs of Messrs. Yarrow, has just completed successful trials on the Clyde, and has now returned to Holland.

Messrs. Wild-Barfield Electric Furnaces, Limited, of Elecfurn Works, North Road, Holloway, London, N.7, have received an order from home manufacturers for several Gibbons-Wild-Barfield electric furnaces. The contract is, it is believed, the largest ever placed in this country for electric resistance furnaces, two of which are the largest ever built in Great Britain, each having a capacity of 7 tons. The complete installations comprise furnaces, controls, and electrically and hand-operated charging machines.

The fate of the Mossend steelworks appears to be quite plain to those people who heard the remarks of Mr. Rencke, the managing director of Messrs. William Beardmore & Company, Limited, in the course of a speech at luncheon after the launching of the "Pole Star." He stated that, while the potentialities of the Mossend steel plant would always have to be taken into consideration in any rationalisation scheme for the Scottish steel industry, there was no immediate prospect of these works commencing to function under the present industrial conditions. This statement appears to dispose of the rumour that the plant was to be shipped to South Africa.

The Austin Motor Company, Limited, has placed a contract with Messrs. Herbert Morris, Limited, for all the conveying and handling plant required for their foundry re-organisation scheme. This plant comprises conveyors for sand reclaiming and distribution, machinery for sand mixing and revivifying, together with conveyors for moulding and casting operations in both the iron and the steel sections of the foundry. The contract is to the value of £10,000, and it has been secured in the face of all the available competition, both home and foreign. It is noteworthy that the consulting engineers are an American firm, who could hardly be accused of an unfair bias in favour of a British maker of conveyors.

In connection with the building of a new steelworks in Pretoria, the South African Steel & Iron Industrial Corporation, Limited, announces that the most acceptable tenders for the plant in the main departments were :—Steel-melting shop and rolling-mill departments, Messrs. Dorman, Long-Demag; blast-furnace plant, Messrs. Ashmore, Benson, Pease & Company; coking and by-product plant, Messrs. Woodall, Duckham & Company. Messrs. Dorman, Long & Company, it is stated, jointly tendered with the German concern, Demag. The latter will probably build a steel furnace and two rolling mills, whilst Messrs. Dorman, Long will supply the steel for the fabrication in South Africa of steel-frame buildings. The contracts will involve an expenditure of roughly £2,300,000.

A prosperous future for British shipbuilding was prophesied by Sir Alexander M. Kennedy at the recent annual meeting of the Fairfield Shipbuilding & Engineering Company, Limited. "The depression through which our large industries are passing as a result of the unsettled conditions in world trade is aggravated," he said, "by the excessive burdens of taxation which national and municipal authorities continue to impose upon British trade and industry, and, notwithstanding the many protests that have been made by responsible and informed authorities, retrenchment is a word which is evidently still unknown in official circles. While the outlook at the moment is not very promising, I am not despondent as regards the future of the industry, and, with the stability in world trading which is certain to come, British shipbuilding will resume its rightful place among the world's industries." Sir Alexander further stated that he had always held that it ought to be a very definite part of the Government policy to anticipate their warship-building programmes at periods when commercial enterprise was lacking.

Personal.

Mr. Geoffrey Summers and Mr. Spencer Summers, directors of Messrs. John Summers & Sons, Limited, of Shotton, are now on a business visit to the United States of America.

Captain H. J. Kennard, R.N., managing director of the Falkirk Iron Company, Limited, has been appointed fourth Bailie of the Burgh of Falkirk. He has also been elected to the Convenorship of the Gas Management Committee.

Mr. Watson Slack, J.P., chairman of the Management Committee of the London Iron and Steel Exchange, has been created a Chevalier de l'Ordre de la Couronne of Belgium, and has received His Majesty's permission to wear the insignia of the Cross of the Chevalier of the Order.

Mr. Arthur Dorman, joint managing director of Messrs. Dorman, Long & Company, Limited, was elected President of the British Steelwork Association at the annual meeting held on October 30. Mr. J. H. Humphryes, chairman of directors of Messrs. Braithwaite & Company (Engineers), Limited, was elected Vice-President.

Wills.

McLaren, P., of Central Avenue North, Mount Vernon, Glasgow, brassfounder £7,998

Turnbull, J., J.P., associated with Messrs. T. Turnbull & Son, shipbuilders, of Whitby, Yorks £149,949

Rowe, Mrs. R., chairman of Messrs. John Buckley (Dudley), Limited, iron and brass founders, of the Royal Works, Dudley £6,280

Vick, R. W., formerly of West Hartlepool, shipbuilder, one of the original directors of Messrs. Furness, Withy & Company, Limited £161,359

Withers, T. J., J.P., for over 50 years associated with the Patent Shaft & Axletree Company, Limited, of the Brunswick Works, Wednesbury ... £9,385

Obituary.

Mr. E. A. W. Jefferies, manager of the gas-producer department of the Morgan Construction Company, Worcester, U.S.A., died on October 20 at the age of 68 years. He was born in England and went to America when he was 20 years old.

Mr. John Walker, chairman and managing director of Messrs. Walker, Hunter & Company, Limited, Port Downie Iron Works, Falkirk, died at his residence in Edinburgh on November 1. He was in his 55th year, and had been at business the previous day, apparently in good health.

Mr. W. H. Pearson, secretary of the Steel Company of Scotland, Limited, died in Glasgow on November 2. He had been connected with the firm for over 50 years. Mr. Pearson acted as the employers' secretary of the Joint Boards of Conciliation and Arbitration for the Manufactured Steel Trade of the West of Scotland, and he was also secretary of the Scottish Branch of the Iron and Steel Trade Employers' Association

Reports and Dividends.

Electric Furnace Company, Limited.—Interim dividend of 3½ per cent. on the preferred ordinary shares, payable on January 1, 1931.

Leeds Fireclay Company, Limited.—Net profit, £87,465; brought in, £20,148; debenture and loan interest, £9,476; dividends of 12½ per cent. on the preference and 10½ per cent. on the ordinary shares; carried forward, £25,137.

John I. Thornycroft & Company, Limited.—Final dividend of 5¼ per cent. on the 7½ per cent. participating preferred ordinary shares, making 9 per cent. for the year, and a dividend of 13 per cent. on the ordinary shares for the year.

Darwins, Limited.—The directors have decided not to make an interim distribution on the 7½ per cent. preference shares, but will wait until the accounts for the year ending March 31, 1931, are available before definitely deciding on such distribution.

New Companies.

Anglo-Peruvian Metals Company, Limited.—Capital £15,000, in 280,000 1s. ordinary and 1,000 £1 7½ per cent. non-cumulative participating preferred shares. Solicitors: Buckeridge & Braune, 3-4, Clement's Inn, Strand, London, W.C.

Perma-Led Metal Company, Limited, 4, Tulip Place, Bermondsey, London, S.E.—Capital £100. Directors: C. Lane, J. B. Lane and P. I. Keane.

Pollock, Brown & Company, Limited.—Capital £1,000. Iron, steel and metal merchants, etc. Solicitors: Harris, Chetham & Cohen, 6, Stratford Place, London, W.

Contracts Open.

Bucharest, November 26.—Cast-iron high-pressure pipes, 100, 200, 700 and 900 mm. dia., etc., for the Bucharest Water Works. Service des Exploitations de l'Eau, Bucharest.

Dublin, November 17.—Iron and steel stores, for the Great Northern Railway (Ireland). Mr. F. C. Wallace, secretary, Amiens Street Station, Dublin.

Dublin, November 26.—Iron and steel stores, for the Great Southern Railway Company. The Stores Superintendent, General Stores Department, G.S. Railways, Inchicore, Dublin.

Edinburgh, November 18.—625 tons of cast-iron or steel pipes, for the Town Council. Messrs. J. & A. Leslie & Reid, water engineers, 29, Waterloo Place, Edinburgh.

London, N.W., November 17.—Pumping station, etc., for the Hendon Urban District Council. Mr. A. O. Knight, engineer, Town Hall, Hendon, N.W.4. (Fee £5 5s., returnable.)

Loughborough, Leics, November 17.—Pumping station, etc., for the Town Council. Mr. W. Granger, borough surveyor, Town Hall, Loughborough. (Fee £2 2s., returnable.)

Malton, November 19.—Two vertical-spindle well pumps and two horizontal pump sets, etc., for the Rural District Council. Mr. J. Hutton, consulting engineer, Osgodby, near Scarborough.

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should be jointed with

"PYROLYTE"

because

the joints of firebrick linings in steel ladles are a source of weakness and go first, especially on the "striking-side."

If the bricks on the "striking-side" of a ladle are set with "Pyrolyte," they will last twice as long as bricks set in Fireclay on the opposite side.

Try this and see for yourself!

ONE OF SHEFFIELD'S MOST FAMOUS STEEL WORKS HAS PROVED THIS CONCLUSIVELY AND HAS DECIDED TO ADOPT "PYROLYTE" ACCORDINGLY!

Sample 1-cwt. drum, 30/- nett delivered.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Although the better feeling recently manifest in the Cleveland iron trade has not entirely disappeared, it cannot be said that any noteworthy improvement in conditions has taken place. There are as yet few signs of returning animation. When consumers come into the market they buy, as a rule, only enough iron to carry them over two or three weeks, and very little forward buying is taking place. Contract business is largely in abeyance. The market derived some satisfaction from the fact that shipments of pig-iron from the Tees in October were heavier than for twelve months past, but against this has to be set the knowledge that shipment of certain September orders was delayed, while at the same time imports of foreign iron last month were much heavier than usual. One of the biggest foundries in the district is stated to be almost exclusively using Belgian iron, which is being delivered at a price considerably below that at which the local product is obtainable.

There is no improvement in industry likely to bring a consequential expansion in the demand for pig-iron, and, apart from this, there seems to be less confidence now in the probable maintenance of the present price level. This also tends to restrict buying. Generally speaking, current deliveries about absorb the output, but the furnace owners have few orders on their books and their position is not strong. Selling prices, however, are unchanged, the ironmasters' official quotations remaining as follow:—No. 3 Cleveland G.M.B., 63s. 6d.; No. 1 foundry, 66s.; No. 4 foundry, 62s. 6d.; No. 4 forge, 62s. per ton.

Sales of East Coast hematite are maintained at recent levels, although their volume remains very unsatisfactory. In spite of the extent to which output has been reduced, stocks at makers' works are still heavy, and they do not seem to become any smaller. The current market rates are 71s. for East Coast mixed numbers and 71s. 6d. for No. 1 quality, but prompt lots can be bought below these figures.

LANCASHIRE.—The demand for pig-iron in the Lancashire area remains restricted, owing to curtailed activity at the works. Consumers persist in their policy of buying only sufficient iron to cover their immediate needs. They will not cover forward, maintaining that future prices are more likely to favour buyers than otherwise. The position at the furnaces varies a little. One of the Derbyshire makers is stated to have made fair sales, but deliveries from other works have fallen away. Prices remain unchanged at 72s. per ton for either Staffordshire or Derbyshire No. 3 foundry iron delivered in the Manchester zone, with forge iron at 5s. per ton less, and Scottish foundry iron at 91s. to 92s.

THE MIDLANDS.—No new feature has developed in this district. The ironfounders are not busy, and the orders which are being sent forward to the furnaces are for small supplies to cover early needs. Consumers will not consider buying forward at current rates. Interest in this area is mainly centred in the deliveries of Continental iron which have taken place, more of this iron having come through than has been the case for a considerable time past. Consumers do not want to go abroad for their supplies, and many of them refuse to do so. Those who are buying the iron maintain that present conditions are such that they are compelled to take advantage of the disparity in price. Continental No. 3 foundry iron has been bought at between 66s. 6d. and 67s. 6d. delivered into works in the Black Country area, these figures comparing with 70s. delivered station, or 70s. 11d. into works, for Northamptonshire iron. The rate for Derbyshire and Staffordshire iron remains at 73s. 6d. delivered Birmingham and Black Country stations.

SCOTLAND.—The Scottish pig-iron market remains very depressed. The foundries are poorly engaged and their pig-iron requirements are small. The business being done with the Scottish furnaces is of a hand-to-mouth character. There continues to be a moderate demand for Continental foundry, and business has been done over the first quarter of next year. There is only a poor demand for Middlesbrough iron, in spite of the fact that special prices are quoted to Scottish consumers. The price of Scottish iron is unchanged on the basis of 76s. 6d. for No. 3 foundry f.o.t. furnaces.

Finished Iron.

Prices of bar iron are without change. There is still a fair demand for Staffordshire marked bars at £12 10s. per ton at works, but orders for cheaper grades of finished iron are very scarce. In nut and bolt iron, particularly, the makers are poorly engaged. This description of iron is being quoted by Continental works at about £5 6s. per ton delivered to Black Country users, whereas Staffordshire makers are quoting £9. The quality of the Continental iron cannot, of course, be compared with the Staffordshire makes, but the wide margin of price seems in most cases to outweigh this consideration.

Steel.

Trade in semi-finished steel is restricted. The British makers adhere to their prices, and values of Continental semis do not appear to have registered any further fall. The demand is not likely to expand until consumers can see a more favourable future with regard to the disposal of finished products, which at present have a restricted market. Conditions vary at the different works, but few of them are busy. The outlook in the shipbuilding industry is not conducive to hopes of any substantial improvement for plates and heavy sections. The lack of orders and the small quantities which consumers are specifying makes steady and economical rolling almost impossible, and plant is compelled to work intermittently. The small steel-bar market is still subject to low-price Continental competition. There is a moderately good demand for special steels.

Scrap.

Inactivity of consuming works in all areas is reflected in the reduced demand for iron and steel scrap. Consumers are not only refraining from placing new business, but are curtailing deliveries under old contracts, and merchants have difficulty in finding outlets for their surplus material. On Tees-side heavy cast iron is on offer at 51s. per ton, with 53s. 6d. quoted for good machinery quality in handy sizes. In Scotland, also, all classes of cast-iron scrap continue to be very plentiful. Several lots of machinery cast have been offered at 57s. 6d. to 60s., but little business has been transacted at these figures. Ordinary heavy cast-iron scrap in foundry pieces is at 52s. 6d. to 55s. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Prices of standard copper have fluctuated, with an upward tendency in evidence this week. Following reports from the United States regarding schemes for curtailment of production, sentiment improved, and the standard market was at one time bid up to within £1 of electro. Buying on the Continent developed on a big scale, Germany being particularly prominent, while this country was not far behind. The market, however, still lacks strength. Unfortunately, the Incorporated Exporters have once again adopted the tactics of restricted quotas, except that on this occasion the daily tonnage allocated to Europe has been smaller than ever.

Closing quotations :—

Cash.—Thursday, £43 3s. 9d. to £43 6s. 3d.; Friday, £43 8s. 9d. to £43 10s.; Monday, £44 8s. 9d. to £44 10s.; Tuesday, £44 10s. to £44 11s. 3d.; Wednesday, £45 to £45 2s. 6d.

Three Months. — Thursday, £43 2s. 6d. to £43 5s.; Friday, £43 7s. 6d. to £43 8s. 9d.; Monday, £44 8s. 9d. to £44 10s.; Tuesday, £44 12s. 6d. to £44 13s. 9d.; Wednesday, £45 2s. 6d. to £45 5s.

Tin.—Consumers of tin have not shown much interest and prices have again declined. Visible supplies at October 31 showed a decrease of about 950 tons, but the Straits carry-over was increased by 1,600 tons. Events have shaken consumers' confidence, for, although the programme of restriction is understood still to be in progress, the "bullish" sentiment so noticeable of late has evaporated.

Official closing prices :—

Cash.—Thursday, £113 to £113 5s.; Friday, £112 2s. 6d. to £112 5s.; Monday, £112 to £112 2s. 6d.; Tuesday, £111 10s. to £111 12s. 6d.; Wednesday, £110 7s. 6d. to £110 10s.

Three Months.—Thursday, £114 10s. to £114 15s.; Friday, £113 10s. to £113 12s. 6d.; Monday, £113 5s. to £113 7s. 6d.; Tuesday, £112 17s. 6d. to £113; Wednesday, £111 15s. to £111 17s. 6d.

Spelter.—The spelter market has developed strength rather unexpectedly, quite a sharp advance being seen at one time on a small turnover. Buying by consumers is light, but confidence in the metal is undoubtedly on the increase.

Daily fluctuations :—

Ordinary.—Thursday, £15 2s. 6d.; Friday, £14 13s. 9d.; Monday, £14 13s. 9d.; Tuesday, £14 10s.; Wednesday, £14 13s. 9d.

Lead.—A steady tone is apparent in this market. Buyers have shown a fair amount of interest, but purchases are hardly on a scale sufficient to absorb current production, although this has been reduced to some extent. For the present the Lead Pool has a firm grip on the market.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £15 15s.; Friday, £15 10s.; Monday, £15 10s.; Tuesday, £15 10s.; Wednesday, £15 8s. 9d.

United Steel Companies, Limited.

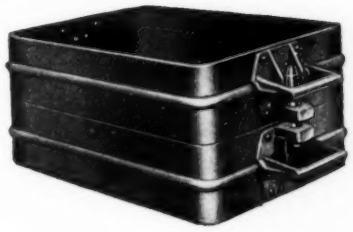
Position of Reconstructed Company.

As a result of the reorganisation of the United Steel Companies, Limited, which took place earlier in the current year and has received Court sanction, the old companies have come to an end and there will be no formal accounts to present for the year ended June 30 last. The new company having been registered in August of this year only, there will be no formal accounts to present to the shareholders of the new company until those for the year ending June 30, 1931, are available. In these circumstances the directors have issued a report on the present position of the reconstructed company and announce the results for the year ended June 30 last. In carrying out the reorganisation, the simplest procedure was adopted, causing the least disturbances to the company's business. Consequently no break whatever has occurred in the business and the new company automatically has become possessed of all the assets and liabilities (other than those cancelled by the scheme) of the old companies.

It will be recalled that Austin Friars Trust failed to provide the funds for the repayment of bank indebtedness. For this reason it has not been possible to carry out the original intention to form the reconstructed capital all in ordinary shares, and it has been necessary to introduce loan capital to the extent of £1,300,000. Nevertheless, taking into consideration all the circumstances and the difficulties encountered, the directors regard the financial position of the reconstructed, or more accurately the new, company with satisfaction. The fixed assets stand at £7,371,682 and the current assets exceed current liabilities by £1,880,712. In the opinion of the directors the value attached to the fixed assets is conservative.

The trading results for the year ended June 30 last are as follow:—Trading profit, £651,019; interest payable by branches and subsidiary and associated companies, £108,823; dividends on preference shares of associated companies not owned by the company, £7,456; reserve for taxation, £51,157; carried to profit and loss account, £483,583.

The sales of the company's products until the month of March were maintained at a figure which, although below the capacity of the company's works, showed continued progress, and the improvement in the trading profit is the result of the increased turnover and of economies effected in costs of production. Although the fall in sales during the June quarter had the effect of reducing the profit which earlier in the year it was anticipated would be realised, the result of the year's working indicates continued progress and confirms the confidence of the directors in the soundness and earning capacity of the company's properties.



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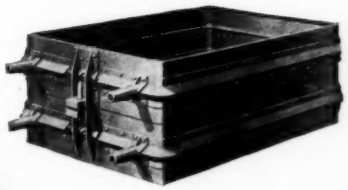
STERLING
ROLLED STEEL
MOULDING BOXES

have been designed for THE MODERN FOUNDRY.

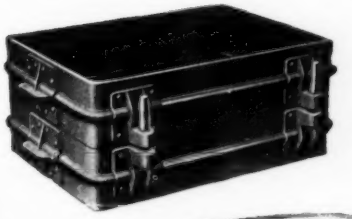
They are light and easy to handle.
Cannot crack or break.
Cannot spring.
Strong, Rigid, Durable and Permanently accurate.



BY ADOPTING STERLING BOXES IN YOUR FOUNDRY,

You will halve your moulding costs. You will increase production per man per hour, and reduce your box maintenance costs. You will turn out more accurate castings and thereby reduce your scrap and reject accounts. You will considerably reduce your fettling costs and put money into your pocket that is now running to waste.

STERLING BOXES save their cost in a few months and are obviously a sound investment for any foundry.



STERLING FOUNDRY SPECIALTIES Ltd.
BEDFORD.

Agents at:—London, Manchester, Newcastle and Glasgow.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	45	0	0
Three months	45	2	6
Electrolytic	47	10	0
Tough	44	5	0
Best selected	44	15	0
Sheets	73	0	0
India	56	15	0
Wire bars	45	5	0
Do. November	45	5	0
Do. February	45	5	0
Ingot bars	45	5	0
H.C. wire rods	47	12	6
Off. av. cash, October	43	1	5 5/16
Do., 3 mths. October	43	0	8 17/16
Do., Sttlmnt., October	43	1	1 1/16
Do., Electro, October	46	6	6 8/16
Do., B.S., October	45	14	8 3/16
Do., wire bars, October	46	17	7 3/16
Solid drawn tubes			11d.
Brazed tubes			11d.
Wire			7½d.

BRASS.

Solid drawn tubes	9½d.
Brazed tubes	11½d.
Rods, drawn	9½d.
Rods, extd. or rlld.	5½d.
Sheets to 10 w.g.	8½d.
Wire	8d.
Rolled metal	7½d.
Yellow metal rods	5½d.
Do. 4 × 4 Squares	6d.
Do. 4 × 3 Sheets	6½d.

TIN.

	£	s.	d.
Standard cash	110	7	6
Three months	111	15	0
English	111	10	0
Bars	114	10	0
Straits	116	5	0
Australian	114	10	0
Eastern	117	10	0
Banca	116	10	0
Off. av. cash, October	117	11	1 1/16
Do., 3 mths., October	119	0	5 5/16
Do., Sttlmt., October	117	11	1 3/16

SPELTER.

	£	s.	d.
Ordinary	14	13	9
Remelted	12	10	0
Hard	11	0	0
Electro 99.9	16	15	0
English	14	17	6
India	12	0	0
Zinc dust	20	0	0
Zinc ashes	3	10	0
Off. aver., October	14	13	9 1/16
Aver., spot, October	14	8	10 3/16

LEAD.

	£	s.	d.
Soft foreign ppt.	15	8	9
English	17	0	0
Off. average, October	15	14	2 1/16
Average spot, October	15	14	11 3/16

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	0	0
Do. V.M. ex-whf.	24	15	0
Rods	28	0	0
Boiler plates	21	0	0
Battery plates	21	0	0

ANTIMONY.

	£	s.	d.
Special brand, Eng.	36	0	0
Chinese	25	0	0
Crude	22	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 17 6
45/50%	£11 10 0
75%	£18 10 0
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/2 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	11½d. lb.
Ferro-phosphorus, 20/25%	£15 15 0
Ferro-tungsten—	
80/85%	2/3 lb.
Tungsten metal powder—	
98/99%	2/6 lb.
Ferro-chrome—	
2/4% car.	£30 10 0
4/6% car.	£23 5 0
6/8% car.	£22 7 6
8/10% car.	£22 0 0
Ferro-chrome—	
Max. 2% car.	£32 17 6
Max. 1% car.	£37 15 0
Max. 0.70% car.	£40 17 6
70% carbon-free	11d. lb.
Nickel—99% cubes, or pellets	£175 0 0
Ferro-cobalt	9/7 lb.
Aluminium 98/99%	£85 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£11 0 0 to £11 15 0
76/80% packed	£12 0 0 to £12 15 0
76/80% export	£10 10 0 to £11 0 0
Metallic manganese—	
94/96% carbonless	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 2
Finished bars, 18% tungsten	£0 3 0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ¼ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy steel				2	12	6
Bundled steel and shrngs.				2	2	6
Mixed iron and steel	2	2	6 to	2	5	0
Heavy cast iron				2	10	0
Good machinery for foundries				2	13	6
Cleveland—						
Heavy steel				2	5	0
Steel turnings				1	17	6
Cast-iron borings				1	10	0
Heavy forge				3	2	6
W.I. piling scrap				2	17	6
Cast-iron scrap	2	11	0 to	2	13	6
Midlands—						
Ord. cast-iron scrap				2	5	0
Heavy wrought				2	15	0
Steel turnings	1	0	0 to	1	2	6
Scotland—						
Heavy steel				2	10	0
Ordinary cast iron				2	12	6
Engineers' turnings				1	16	0
Cast-iron borings				1	15	0
Wrought-iron piling				3	3	6
Heavy machinery				2	17	6

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	37	0	0
Brass	26	0	0
Lead (less usual draft)	13	15	0
Tea lead	10	5	0
Zinc	7	10	0
New aluminium cuttings	50	0	0
Braziery copper	34	0	0
Gunmetal	37	0	0
Hollow pewter	76	0	0
Shaped black pewter	54	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	66/-
Foundry No. 3	63/6
Foundry No. 4	62/6
Forge No. 4	62/-
Hematite No. 1	71/6
Hematite M/Nos.	71/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	78/6
,, d/d Birm.	88/6
Midlands—	
Staffs. common*	—
,, No. 4 forge*	68/6
,, No. 3 fdry.*	73/6
Shrops. basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	65/-
,, fdry. No. 3*	70/-
Derbyshire forge*	68/6
,, fdry. No. 3*	73/6
,, basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	79/-
,, No. 3	76/6
Hem. M/Nos.	77/-
Sheffield (d/d district)—	
Derby forge	63/6
,, fdry. No. 3	68/6
Lincs. forge	—
,, fdry. No. 3	70/-
E.C. hematite	83/6
W.C. hematite	86/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	67/-
,, fdry. No. 3	72/-
Staffs foundry No. 3	72/-
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	91/6
Glengarnock, No. 3	—
Eglinton, No. 3	91/6
Gartsherrie, No. 3	91/6
Monkland, No. 3	91/6
Shotts, No. 3	91/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	10	0	0 to	10	15	0
Nut and bolt iron				9	0	0
Hoops	10	15	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	10	0
Gas strip	10	15	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.				15	5	0
Steel—						
Ship plates	8	15	0 to	8	17	6
Boiler plts.	9	7	6 to	10	5	0
Chequer plts.				10	12	6
Angles				8	7	6
Tees				9	7	6
Joists				8	10	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ¾ in. (Untested)				7	12	6
				and upwards		
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy				8	10	0
Fishplates				12	0	0
Hoops (Staffs)	9	5	0 to	9	10	0
Black sheets, 24g.	8	15	0 to	9	15	0
Galv.cor.shts., 24g.				11	12	6
Galv. fencing wire, 8g. plain				12	0	0
Billets, soft	5	12	6 to	6	5	0
Billets, hard	7	10	0 to	8	0	0
Sheet bars	5	12	6 to	5	15	0
Tin bars				5	15	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/-
Sheet to 10 w.g.	1/0½
Wire	1/0½
Rods	1/0½
Tubes	1/5½
Castings	1/1

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	8d. to 1/2
Rolled—	
To 9 in. wide	1/2 to 1/8
To 12 in. wide	1/2½ to 1/8¼
To 15 in. wide	1/2½ to 1/8½
To 18 in. wide	1/3 to 1/9
To 21 in. wide	1/3½ to 1/9½
To 25 in. wide	1/4 to 1/10
Ingots for spoons and forks	8d. to 1/4½
Ingots rolled to spoon size	11d. to 1/7½
Wire round—	
3/0 to 10 G.	1/5½ to 2/0½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	18.76
No. 2 foundry, Valley	17.00
No. 2 foundry, Birm.	14.00
Basic	18.76
Bessemer	19.26
Malleable	19.26
Grey forge	18.76
Ferro-mang. 80%	94.00
O.-h. rails, h'y, at mill	43.00
Billets	31.00
Sheet bars	31.00
Wire rods	36.00
	Cents.
Iron bars, Phila.	2.09
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Skelp, sheared steel	1.70
Steel hoops	1.95
Sheets, black, No. 24	2.45
Sheets, galv., No. 24	2.95
Sheets, blue an'l'd, No. 13	2.05
Wire nails	1.95
Plain wire	2.30
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$5.00

COKE (at ovens).

Welsh foundry	24/- to 27/6
,, furnace	17/- to 20/-
Durham and Northumberland—	
,, foundry	14/6 to 15/-
,, furnace	14/6
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	17/-
,,	28×20 ,,	34/-
,,	20×10 ,,	24/6
,,	18¾×14 ,,	17/9
C.W.	20×14 ,,	15/6
,,	28×20 ,,	32/-
,,	20×10 ,,	23/6
,,	18¾×14 ,,	17/-
Terneplates	28×20	31/- per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 10 0
Bars, hammered, basis	£17 10 0 to £18 10 0
Bars and nail-rods, rolled, basis	£15 17 6 to £16 15 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£20 0 0 to £24 0 0
Bars and rods dead soft, steel	£11 0 0 to £14 0 0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ½ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	62½%	47½%
Water ..	58½%	42½%
Steam ..	55%	37½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Nov.	6 ..	43	3	9	inc.	6/3
,,	7 ..	43	8	9	,,	5/-
,,	10 ..	44	8	9	,,	20/-
,,	11 ..	44	10	0	,,	1/3
,,	12 ..	45	0	0	,,	10/-

Electrolytic Copper.

		£	s.	d.		
Nov.	6 ..	45	5	0	No change	
,,	7 ..	45	5	0	,,	,,
,,	10 ..	45	5	0	,,	,,
,,	11 ..	45	5	0	,,	,,
,,	12 ..	47	10	0	inc.	45/-

Standard Tin (cash).

		£	s.	d.		
Nov.	6 ..	113	0	0	inc.	30/-
,,	7 ..	112	2	6	dec.	17/6
,,	10 ..	112	0	0	,,	2/6
,,	11 ..	111	10	0	,,	10/-
,,	12 ..	110	7	6	,,	22/6

Tin (English ingots).

		£	s.	d.		
Nov.	6 ..	114	0	0	inc.	30/-
,,	7 ..	113	5	0	dec.	15/-
,,	10 ..	113	0	0	,,	5/-
,,	11 ..	112	10	0	,,	10/-
,,	12 ..	111	10	0	,,	20/-

Zinc Sheets (English).

		£	s.	d.		
Nov.	6 ..	24	0	0	No	change
,,	7 ..	24	0	0	,,	,,
,,	10 ..	24	0	0	,,	,,
,,	11 ..	24	0	0	,,	,,
,,	12 ..	24	0	0	,,	,,

Spelter (ordinary).

		£	s.	d.		
Nov.	6 ..	15	2	6	inc.	5/-
,,	7 ..	14	13	9	dec.	8/9
,,	10 ..	14	13	9	No	change
,,	11 ..	14	10	0	dec.	3/9
,,	12 ..	14	13	9	inc.	3/9

Lead (English).

		£	s.	d.		
Nov.	6 ..	17	5	0	No	change
,,	7 ..	17	0	0	dec.	5/-
,,	10 ..	17	0	0	No	change
,,	11 ..	17	0	0	,,	,,
,,	12 ..	17	0	0	,,	,,

AVERAGE MONTHLY PRICES OF IRON HOOPS.

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1896	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 5 0	6 10 0	6 3 0
1897	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 8
1898	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 15 0	6 15 0	7 0 0	6 11 6
1899	7 0 0	7 0 0	7 0 0	7 0 0	7 12 6	10 12 6	8 12 6	8 12 6	8 12 6	9 2 6	9 7 6	9 17 6	8 2 9
1900	9 17 6	10 7 6	10 7 6	10 7 0	10 12 6	7 12 6	10 12 6	10 12 6	10 12 6	9 17 6	9 2 6	9 2 6	10 3 8
1901	9 2 6	8 2 6	8 2 6	7 12 6	7 12 6	7 12 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 11 2
1902	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6
1903	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 0
1904	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6
1905	6 17 6	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 2 6	7 2 6	7 2 6	7 7 6	7 0 0	7 7 6	7 2 0½
1906	7 10 0	7 17 6	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 7 6	7 15 1½
1907	8 7 6	8 7 6	8 7 6	8 7 0	8 7 6	8 7 6	8 10 0	8 10 0	8 10 0	8 5 0	8 5 0	8 0 0	8 7 1
1908	8 0 0	7 10 0	7 10 0	7 10 6	7 10 0	7 10 0	7 10 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 6 8
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0
1910	7 1 10½	7 6 3	7 7 6	7 7 0	7 7 6	7 7 6	7 7 6	7 7 6	7 7 6	7 6 3	7 5 0	7 5 0	7 6 5
1911	7 5 0	7 5 0	7 5 0	7 5 6	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 8 9	7 10 0	7 10 0	7 6 2½
1912	7 12 6	7 12 6	7 12 6	7 15 0	7 15 0	8 2 6	8 2 6	8 2 6	8 12 6	8 12 6	8 12 6	8 15 0	8 2 3½
1913	8 17 6	8 17 6	8 17 6	8 17 0	8 17 6	8 17 6	8 17 6	8 7 6	8 7 6	8 7 6	8 7 6	7 17 6	8 12 6
1914	7 17 6	7 17 6	7 17 6	7 13 9	7 12 6	7 12 6	7 12 6	9 2 6	9 2 6	9 2 6	9 2 6	9 2 6	8 6 4½
1915	9 3 6	9 18 1	10 7 6	10 16 6	10 17 6	13 2 6	13 2 6	13 2 6	13 7 6	14 2 6	15 2 6	15 18 6	12 10 1
1916	17 2 6	17 2 6	17 2 6	17 6 3	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 6 1
1917	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6
1918	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6
1919	17 2 6	17 2 6	17 2 6	17 2 6	24 6 3	24 6 3	24 6 3	25 9 0	26 7 6	26 7 6	26 7 6	26 17 4	22 14 9
1920	28 0 0	28 12 6	33 15 0	35 5 0	35 15 10	38 17 6	38 17 6	38 17 6	38 17 6	38 17 6	36 17 6	36 17 6	35 14 9
1921	29 1 3	23 5 0	21 12 6	20 0 0	20 0 0	20 0 0	17 5 0	15 0 0	14 4 0	13 15 0	13 10 0	12 18 0	17 5 10
1922	16 5 0	15 13 9	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	13 4 6½
1923	14 0 0	15 0 0	15 0 0	15 0 0	15 6 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 16 0	14 15 0	14 18 3½
1924	14 15 0	14 15 0	14 15 0	14 15 0	14 15 0	14 13 9	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 12 4½
1925	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0
1926	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0
1927	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	12 10 0	12 10 0	14 3 4
1928	12 10 0	12 7 6	12 0 0	11 13 6	11 15 0	11 12 6	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 14 10½
1929	11 10 0	11 10 0	11 10 0	11 10 0	11 9 0	11 5 0	11 5 0	11 5 0	11 5 0	11 2 0	11 0 0	11 0 0	11 5 11
1930	11 0 0	11 0 0	11 0 0	10 16 3	10 15 0	10 15 0	10 15 0	10 16 3	10 17 6	10 17 6	—	—	—

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PIG IRON

REGISTERED TRADE MARK

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

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ZETLAND ROAD, MIDDLESBROUGH.

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(A remittance should accompany instructions.)

SITUATIONS WANTED.

FOUNDRYMAN, Manager or Assistant last 18 years, motor cylinders and similar engineering training, commercial experience, actual experience erection and operation cupolas, brass tilting furnaces, stoves and other plant, seeks executive position or as Representative.—Box 1824, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PRACTICAL Iron Moulder (36), thoroughly experienced in cupola practice, loam, dry-sand and green-sand moulding, desires position as Working Foreman or Assistant; 22 years' experience of marine, general engineering and jobbing castings.—Box 674, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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AGENCY.

AGENTS VISITING FOUNDRIES, ENGINEERING Workshops, Shipbuilders, etc., who can carry small additional line on good commission basis are invited to communicate with VIOZONE, LIMITED, 88, 89, 90, Chancery Lane, London, W.C.2.

PATENTS AND TRADE MARKS.

PROTECT YOUR IDEAS.—Free, Advice and Handbook on patenting inventions and registering trade marks by Registered Agent with 43 years' experience.—KING'S PATENT AGENCY, LIMITED, 146A, Queen Victoria Street, E.C.4.

THE Proprietor of British Patent No. 222890, dated October 6, 1923, relating to "Process for Producing Metallurgical Coke," is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above Patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois.

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REGISTERED Company with nominal capital, connected with foundry supply trade, together with patents, etc., for sale. Suitable for one who is desirous of entering the foundry-requisite business. Established about 5 years; good reason for selling. Principals only.—Write, Box 678, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

SMALL Aluminium Foundry for Sale in London with fair connection; accept low figure for goodwill, stock and plant at valuation.—Write, Box 676, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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RYLAND'S DIRECTORY of the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades. 1930 edition. Price 42s., bound in cloth.—INDUSTRIAL NEWSPAPERS, LTD., 49, Wellington Street, Strand, London, W.C.2.

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145,000 Sq. Ft. of SHOPPING,
Compact and Convenient,

SIDING CONNECTIONS

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WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

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TO Engineers, Founders, Manufacturers.—Fine site of nearly three acres on arterial road, with Foundry and Workshops and own Rail Sidings into the premises. Modern Offices, Warehouses and Workrooms. Central Heating.—CHARLES A. TRICKS & SON, Auctioneers, St. Nicholas Street, Bristol.

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THOS. W. WARD, LTD.

12-in. x 12-in. Class E.R.1 INGERSOLL RAND Belt-driven Air Compressor.

WORTHINGTON 8-in. x 12-in. Horizontal Treble-ram Pump.

EVANS 7½-in. x 6-in. Vertical Three-throw Pump, with motor, 220 volts.

100-b.h.p. Horizontal Cold-starting Crude Oil Engine, by RUSTON HORNSBY.

5-ton LOCO. STEAM CRANE (Booth's); 30-ft. jib, 4-ft. 8½-in. gauge, 80 lbs. w.p.

5-ton LOCO. STEAM CRANE (Coles); 42-ft. jib, 4-ft. 8½-in. gauge, 80 lbs. w.p.

One VERTICAL COCHRAN BOILER, 14 ft. 9½ in. x 7 ft. 0 in., working steam pressure 100 lbs. per sq. in.

FOUNDRY LADLES, various types and sizes.

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ALBION WORKS, SHEFFIELD.

MACHINERY—*Continued.*

SAND MIXERS.—New and Secondhand. Ask us to quote.—W. BREALEY & COMPANY, LIMITED, Prospect Works, Hawksley Avenue, Sheffield.

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